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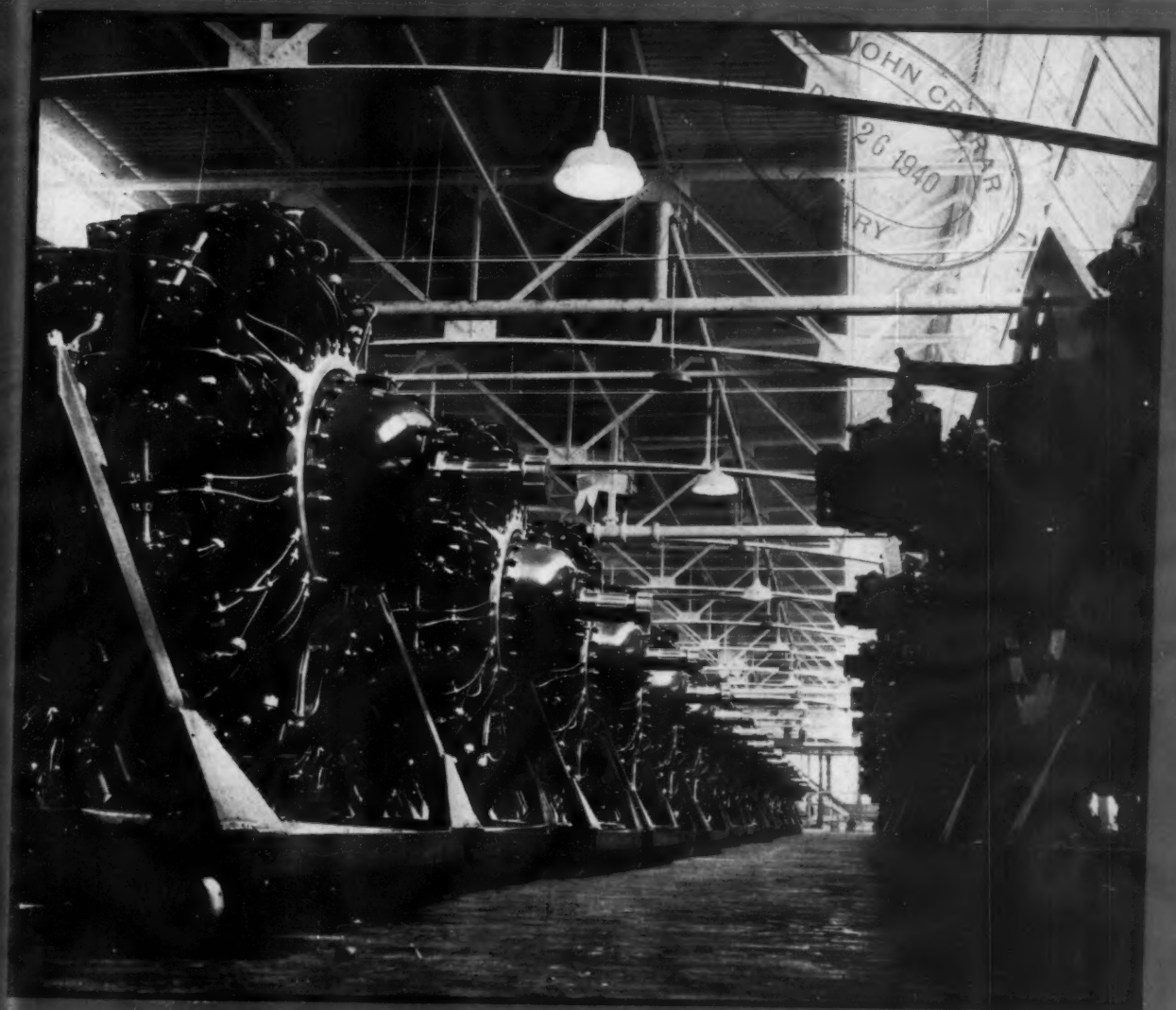

VOLUME 8 DECEMBER, 1940 NUMBER 2

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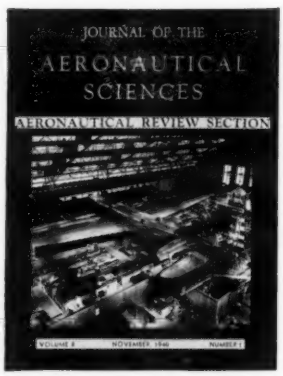

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JOURNAL OF THE AERONAUTICAL SCIENCES

AERONAUTICAL REVIEW SECTION

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Statements and opinions advanced in Reviews are to be understood as individual expressions and not those of the Institute.

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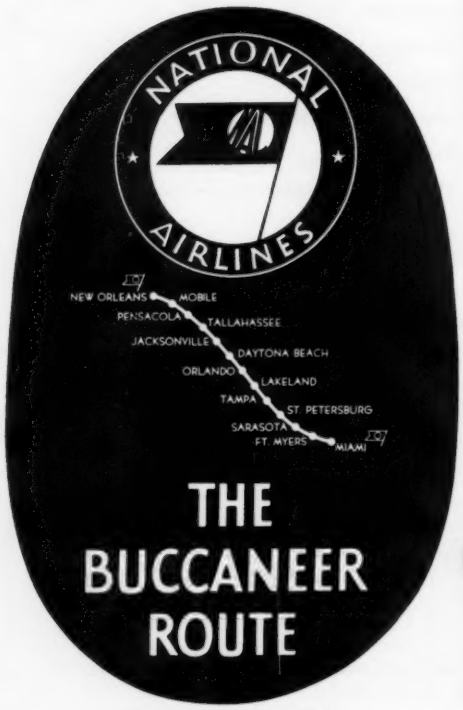
WRIGHT ENGINES — IT PAYS TO FLY — BG SPARK PLUGS



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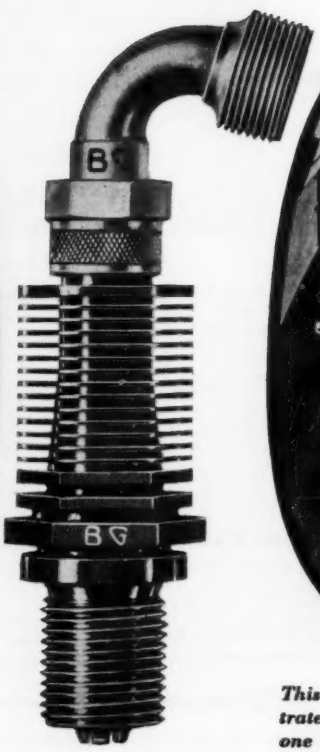

This cross-section of the Lodestar illustrates its unobstructed cabin headroom and one of the spacious cargo compartments.

BG SPARK PLUGS ARE STANDARD EQUIPMENT WITH NATIONAL AIRLINES

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Meeting a Need

THE "READER FOR THE AIRCRAFT INDUSTRY" has brought its editors more appreciative comment than was either expected or deserved.

First issues always fall far short of the standards that were set as goals to be crossed. The Aeronautical Review has found a definite demand which it will be the aim of the editors to satisfy. To put before the aeronautical industry and profession a vivid panorama of progress recorded in aviation literature each month is the objective of the reviewing staff. As the Review is essentially a service publication, its readers may miss the pictures that make other aeronautical periodicals so attractive. Rather than to duplicate the illustrations which appear in the older aviation publications, the Review will print only those pictures which relate to a definite section of the text. To the many who have voiced their approval of the Review, its editors extend their thanks and deepest appreciation.

Presses with Wings

There are many types of books and periodicals dealing with various aspects of aviation. Some are fiction, some popular, some factual but still elementary. Others are semi-technical, and a few are highly specialized engineering treatises. Each has its own sphere of usefulness, filling the needs of different groups.

This is pointed out because the majority of the readers of the Aeronautical Review being engineers, the question may be raised as to why other than engineering works are reviewed. The answer is simple. In the first place, there is an endeavor to survey the entire field of aviation publication. In the second, a guide and reference to non-technical matter is of direct and indirect value to engineers.

Indirectly, an even greater service is rendered by the more popular works in which the technical man may not be personally interested. A work of fiction may, and no doubt often does, serve as an introduction to aviation, arousing a reader's first lively interest in it.

Probably no single industry today is so plentifully supplied with printed works of all kinds as is aviation. This is not only a sign of public interest, but a creator of it. Day by day the printing press helps develop the greater industry of tomorrow.

Dynamic Library

One of the purposes of the Review might be termed a dynamic extension of the library Idea. Its entire book section deals with volumes which not only represent the current output on every phase of aviation but which are part of an endowed lending library service. Books from The Paul Kollsman Library of aviation are available by mail without charge to anyone interested in aviation. The Review serves as an advance guide, enabling readers to select from the great volume of written material new and significant work in their special field.

Librarians say that this is a new method and are watching its success with particular interest. It is believed that through the technical group represented by the readers of the Review, this new idea in library service can be later applied to other technical and professional fields. Thus the Review is not just another aviation periodical but an advanced effort in technical reader service. Librarians hope that, from the experience gained by the Review, the idea may be broadened to cover many other specialized fields. When this is done, the Aeronautical Review may have contributed not only to aeronautics but pioneered in educational library work as well.

Reading Time—1000 Hours!

One of the national weekly magazines prints the average reading time of each of its stories and articles. If the staff of the Aeronautical Review were to do the same for the books, articles, house organs, catalogues, papers and reports reviewed, the total would reach well over one thousand hours of reading. That happens to be a good many more hours than there are in a month, which gives some indication of both the volume of aviation literature published and the magnitude of the problem of keeping abreast of developments in aviation.

With research and design leaping ahead under the spur of air warfare, highly necessary technical reading demands more and more time—with time at a premium.

From this growing problem has come the need and the service idea for the Aeronautical Review. Reading time—1000 hours, surveyed and condensed to one or two hours, not as a substitute but as a guide to the latest aviation literature in the reader's field of interest.

The Paul Kollsman Library

of the

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A new lending library service of the Institute which makes available, without charge, the latest and more important aeronautical books to members of the Institute and others interested in aeronautical progress.

Membership in the library is open to all members of the Institute of the Aeronautical Sciences and to any person in the United States over 18 years of age who can furnish references which certify as to his responsibility and reliability.

The Aeronautical Reader's Guide

A catalogue of selected aeronautical books available for loan from The Paul Kollsman Library. The Guide lists and comments on books and by indexing them under specialized headings also acts as a valuable reference source for aeronautical specialists, companies, libraries and other organizations.

The Guide is issued quarterly in September, December, March and June, and is priced at $1 for the four issues in each volume. Single copies are not available and subscriptions may only be accepted for complete volumes.

Further information will be sent on request.

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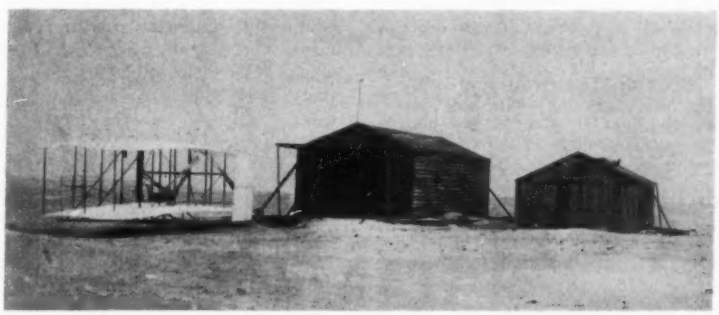
BOOKS

Airport Planning, Design and Expansion

Almost all books on specialized aviation subjects are written by two classes of authors. The first compiles information and presents it without critical comment. The second lets his professional privilege of analysis give the reader not only the results of his research but his frank opinion of the work of others. Mr. Wood has not been backward in his evaluation of airports here and abroad. Many persons who have designed airports and their buildings as well as those who have inherited the work of others may resent some of the observations regarding airport planning, their location, and the design of buildings and hangars. If the author had done otherwise the book would not have been as informative as it is.

Books reviewed in this section may be purchased, or borrowed without charge, from The Paul Kollsman Library, Institute of the Aeronautical Sciences, 1505 RCA Building West, Rockefeller Center, New York, N. Y.



The world's first airplane in front of its hangar at Kitty Hawk, North Carolina, December 1903. This and the following two illustrations are reproduced through the courtesy of the author of "Airports."

As military and commercial aviation have to rely on ground facilities, it is important to have an expert in this field present the results of many years' investigation and personal observation. It is well known that the layout and planning of many important airports has been done in a haphazard manner, principally by local talent, and they have not kept pace with the phenomenally rapid increase in the speed and size of commercial airplanes and airline traffic. In almost every instance the shortcomings of an airport can be traced to a limited area to start with, a layout for aircraft accommodation and traffic long since outgrown, and possibly the lack of such a comprehensive study as has been presented in this book. The result is that airports are passing through a costly period of expansion or redesign which comes from unexpectedly greater use.

There is a large bibliography of airport literature which was prepared under the direction of the Institute with the cooperation of the Works Projects Administration but no other recent book has summed it up in one volume.

The book opens with a brief discussion of the general requirements of the airport and then goes into detailed comparison and analysis (with scale plans and photographs of each airport) of what has been done to date at twenty-two of the most important North and South American airports and at twenty-six of the most important European airports. Much of the information in this section is contained in the 444 photographs and the 64 diagrams and plans which are used to supplement the text. The balance of the book embodies the conclusions arrived at from the preceding chapters and offers a new and advanced system of airport planning based on these findings. This new plan is suitable both for present airport needs and future airport expansion.

There are twenty-two appendixes included which contain information on Air Transport Statistics, Runways, Airport Traffic, Instrument (blind) Landings, Assisted Take-Off, Airports and War, and the Contributions to American Airports by the Bureau of Air Commerce, the Civil Aeronautics Board and the W.P.A.

While *Airports* is designed to appeal particularly to aviation technicians, the many photographs of airports, air transportation, and air views from many parts of the world make it a book which has a strong appeal for the general reader interested in aviation. It is a book for everyone directly engaged in the design, construction, operation or financing of airports. It is a book for architects, engineers, airport managers, federal agencies (both civil and military), and

The Wright airplane at Wright Field, Dayton, Ohio, November 16, 1904. This meadow is the first airplane landing field—the world's first airport.

for manufacturers of airport products. It is a book for members of airport committees, municipalities, airlines. It is a book for aeronautical schools, for writers on aeronautics, for airline pilots, for pilots in the Army and Navy and for pilots of private airplanes.

The book is marred by a series of impressionistic juvenile drawings which give a casual impression of some of the outstanding events in aeronautical history. The other illustrations are selected with care and provide an excellent background for the text. Mr. Poor has made a distinct contribution to the knowledge of the work of the Wright Brothers by securing from Orville Wright an excellent description of the first airport in the world for airplanes at Simms Station near Dayton. There will be a general agreement with Charles L. Lawrance, who wrote in the preface "This work will be a standard book of reference for airport engineers and architects. There will be no reason in the future for poorly designed airports with this book available."

Airports, by John Walter Wood; Coward McCann, Inc., New York, 1940; 364 pages, $12.50.

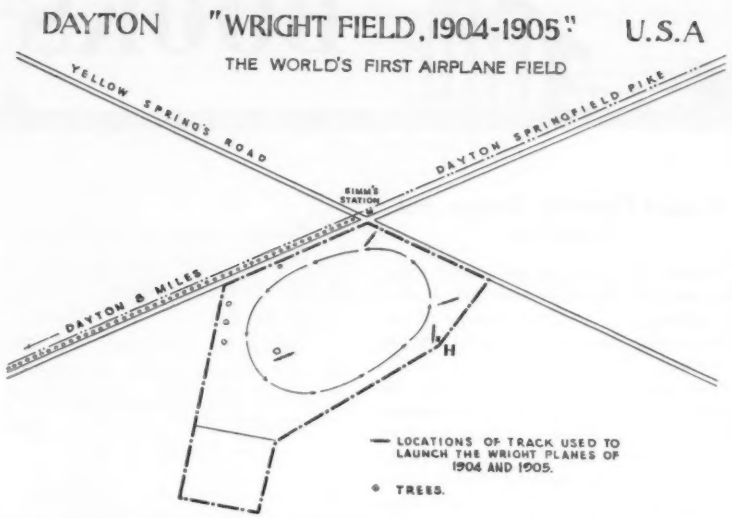
How to Tell Friend from Foe

Airplanes flying at high altitudes often are exceedingly difficult to identify from the ground, and special attention is being given in England to the problem of distinguishing between enemy and friendly aircraft. Training for such identification is given the armed forces, but the public has been forced to rely upon their own information and upon the help of various periodicals. One of these, "The Aeroplane," has issued a small pocket-sized handbook, reprinting illustrations that have appeared in its pages. The pictures show German, British and a few French airplanes from different angles, in photographs and in silhouettes. A brief text suggests the chief features to look for in each airplane.

Aircraft Recognition, by the staff of "The Aeroplane;" The Aeroplane, London, 1940; 36 pages, 1s.3d.

Airplane Picture-Book

Harold H. Booth, formerly an aeronautical draftsman and now with the R.A.F., presents a book of full-color drawings of 24 airplanes, entitled "Book of Modern Airplanes." Aircraft of four countries are presented, the United States, France, Great Britain and Germany. Private, commercial and military airplanes are shown, and with each picture is a brief description. The end papers show simple silhouettes of various airplane types, and there is also a diagram identifying the different parts of an airplane. Though ostensibly intended for young people, the book will interest all who would like to have a good view of the airplanes it illustrates.


DAYTON "WRIGHT FIELD, 1904-1905" U.S.A
THE WORLD'S FIRST AIRPLANE FIELD
YELLOW SPRING'S ROAD
DAYTON SPRINGFIELD PIKE
SIMM'S STATION
DAYTON 6 MILES
H
LOCATIONS OF TRACK USED TO LAUNCH THE WRIGHT PLANES OF 1904 AND 1905.
TREES.

The dimensions of this field may be approximated by the boxed portion of the field (lower left) which measures about 775 ft. on each side.

Book of Modern Airplanes, by Harold H. Booth; Garden City Publishing Co., New York, 1940; 28 pages, $1.00.

Air Transport Financial Analysis

Unlike some previous financial and statistical studies of the aviation industry, which covered both manufacturing and air transportation, this one confines itself to the latter branch. The booklet serves as a basic reference, while "periodic supplements will be issued to keep the study of the fast-moving air transport industry current" and according to the foreword, will form a continuous history of the industry. J. S. Bache and Company, the publishers, are New York brokers with many years' experience in finance.

To furnish a background for the survey of representative individual companies, the industry as a whole is studied first. The three sources of revenue—passenger, mail, and express—are investigated as to the amount they contribute toward the total, and the relative importance of each. The replacement of mail payments by commercial income as the larger source of revenue is pointed out as a healthy sign. The problems of the industry are taken up in some detail. From this the conclusion is drawn that much attention will have to be paid to the effects of the National Defense Program, rising costs of material, and the financing of new equipment.

To facilitate comparison between companies, the studies follow a fixed outline. The territory and present routes are described first, followed by descriptions of new routes, requested equipment, financial condition, revenues, expenses, and earnings. In conclusion there is a table for each company containing financial and operations statistics for the years 1938 through 1940, the last year being estimated. Of particular interest in these tables are the figures showing the percentage of total revenues represented by income from passengers, mail, and express. In the table on Pan American Airways information on the year 1940 is omitted.

Handbook of the Air Transport Industry; J. S. Bache and Company, New York, 1940; 48 pages.

Correct Answers to Radio License Examination Questions

Because of the introduction by the Federal Communications Commission of a new form of radio license examination, embodying six elements, a need has arisen for a modern book giving correct answers to typical examination questions. Wayne Miller provides such a book in his "Radio Operators' License Guide." In it, questions drawn from different examination papers are quoted, with suitable answers.

Questions are included from all six elements of the examinations: law, basic theory and practice, radio-telephony, advanced radio-telephony, radio-telegraphy, and advanced radio-telegraphy. An appendix provides information on the radio inspection districts, F.C.C. rules and regulations, the Q code abbreviations, miscellaneous abbreviations, and International Morse.

Many of the answers to questions are self-explanatory, while others are not,

and therefore the book cannot be recommended for study other than in preparation for an examination. However, it will serve as an excellent way of reviewing one's radio knowledge.

Radio Operators' License Guide, by Wayne Miller; Published by the author, Chicago, 1940; 158 pages, $3.00.

Aviation "Orphans" Look About for Foster Parents

For many reasons, flying in many areas of the United States is handicapped by inadequate landing facilities. The situation has been studied in detail by the C.A.A., and a program has been planned calling for large governmental expenditures which will do much to remedy the present conditions.

However, Lieutenant Colonel Hanks, in his new book, shows that more than Federal action alone is required. State governments are involved, for they must consent to the acquisition of land by the national government, and cooperate in many other ways. This book should be of assistance in obtaining such cooperation. It gives the appreciable value to the community of aviation in general and a properly designed and maintained airport in particular. While the author is quick to confess that the average civil airport in 1938 cost more to maintain than its gross income, he also discusses the favorable effect of an airport upon general business in the area is serves.

Several state enactments bearing upon airports are quoted, and the relationship of airports to the police and to national defense is shown. A few of the chapters have appeared elsewhere as part of the author's endeavors to aid what he calls "the orphan children of the aviation industry." Naturally, as a chief exponent of "flight strips" along highways to function as auxiliary landing fields, he emphasizes their importance in any national defense program.

Aviation Gets Down to Earth, by Lieutenant Colonel Stedman Shumway Hanks; U.S. Army Air Corps Reserve; Aviation Information Service, Boston, Mass., 1940; 121 pages, $2.00.

How the Non-Technical Observer Can Predict Weather

An interesting feature of a new book from England, entitled "Weather Prediction," is the inclusion of an appended supplementary chapter that explains how the ordinary man can estimate the likelihood of approaching weather conditions being favorable or unfavorable for air raids. During war, official meteorological data must be kept secret, and this chapter will therefore be read with unusual interest in England.

The rest of the book consists of a non-technical explanation of the nature and causes of weather phenomena, with explanations of their significance as regards weather forecasting. Anyone who absorbs this information should be able to make some very good guesses. While it is evident that the volume was prepared for the residents of England and Scotland, most of the suggestions and facts are of course applicable throughout the northern hemisphere. South of the equator, corrections in wind directions would be necessary. There is an excellent outline of conditions causing icing during flight, and a thorough description of the British meterological report system.

Weather Prediction, by Major R. M. Lester; Chemical Publishing Co., New York, 1940; 256 pages, $4.25.

Wartime Aviation Romance Is Gripping and Authentic

Nevil Shute's new book, "Landfall," derives an initial prestige from the fact that previous works of fiction by this author have been widely popular, both in England and in the United States. Soon after opening the volume, however, it is easy to see that it needs no advertisement of past performances but can stand on its own feet. In addition to the thrills of wartime flying, it has an appealing romance. The setting is England during this war.

The author is an aeronautical engineer and is in the Admiralty Office in London. Therefore, the flying and other aeronautical details are accurate and the book will arouse no irritation among readers who are acquainted with aviation. On the contrary, it should fascinate them and all others who like a good story with today's background of war in the air.

Landfall, by Nevil Shute; William Morrow & Co., New York, 1940; 284 pages, $2.50.

Pictorial Parade of the World's Military Aircraft

In response to the tremendous civilian interest in military aircraft, Major Bernard A. Law has produced a book that illustrates many of them in large, half-page, full-color sketches. Not only are American airplanes shown, but also some of those in the services of England, France, Germany, Russia, Italy and a number of smaller countries. Not all planes of each country are included, perhaps for censorship reasons, and the descriptive text is limited to such main items as number of engines, horsepower, speed, radius, and armament. In a short foreword, Major Al Williams speaks of the radical change in warfare brought about by the modern plane. Pictures occupy about 50 percent of the book, which is intended for the general public. In all, 65 military planes are shown.

Fighting Planes of the World, by Major Bernard A. Law; Random House, New York, 1940; 66 pages, $1.00.

Career of Navy Enlisted Man Is Described

The average U.S. Navy recruit shows a preference for naval aviation. Kendall Banning's new book, "The Fleet Today," designed to give a picture of the fleet as seen through the eyes of the enlisted man, and the method employed is to take him through his enlistment process, on up through the various tasks, duties, privileges, branches and services that are open to him.

All this is done with considerable detail, yet in an interesting and very readable style. The author has written similar books on the training and careers of Army and Navy officers, and this new volume, like its predecessors, is thorough. Having been prepared with Navy blessing and cooperation, it is authentic. There are two chapters on aviation, and an appendix listing basic data about the fleet.

The book may be recommended as required reading for young men contemplating joining the Navy. It should also be read by their families, to encourage enlistments.

The Fleet Today, by Kendall Banning; Funk & Wagnalls Co., New York, 1940; 346 pages, $2.50.

1940 Year Book Surveys the Industry

The 22nd annual edition of The Aircraft Year Book has already found its place on desks and in the working libraries of the aircraft industry. In its 1940 form, the book surveys the entire aviation industry, recording progress and accomplishment during the preceding year. Of its 532 pages, more than half are devoted to chapters that present a running account of aeronautical developments of current interest. There is a chapter reviewing air warfare, and four chapters explain the work of various governmental agencies, including the Army and Navy, with and for aviation.

Other chapters discuss commercial and private flying, airports and airways, aviation organizations, activities of the states, training and education, and manufacturing. An illustration appears on almost every page.

The rest of the book contains aircraft and engine specifications and designs,

a chronology for 1939, a directory, the Neutrality and Foreign Loan acts, and numerous statistical tables. As always, it is the indispensable reference book for following American aeronautical progress.

The Aircraft Year Book for 1940, Howard Mingos, Editor; Aeronautical Chamber of Commerce of America, New York, 1940; 532 pages, $5.00.

The Art of Modern Warfare

Someone said, soon after the present war started, that military and naval books on strategy and tactics would become obsolete so quickly as to make them historical documents rather than textbooks for problems of modern military operations. This is a typical exaggeration so often heard following the introduction and spectacular use of new instruments of warfare.

In reviewing the remarkably clear statement of Colonel Foertsch of the German General Staff, outlining the role of armies, the impression is gained that, informed military expert as he is, he did not foresee the importance of air forces in the present war.

Discussing General Douhet's doctrine of total air warfare, he declares it to be a fallacy that an opponent can be compelled to fight for the command of the air. The claim is advanced that absolute domination of the air can be attained over certain areas and for limited times only but solely over territory in which the enemy has been defeated and even then only for so long as he remains defeated. It is astonishing to have a military expert state that an attack can be split up by the defense "dividing air forces among many airports, moving them at night or undertaking all sorts of deception, camouflage and defensive measures. There is no domination possible of any permanency, for what cannot be occupied cannot be retained permanently."

In his chapter on weapons of today he describes the use of aircraft as a service of the army and although the book is entitled "Modern Warfare" he omits any discussion of the conduct of air war, declaring that an account of the principles and methods involved should be reserved for treatment by an air expert.

Apart from its casual reference to air power the book is an excellent presentation of the history and employment of various military arms. He writes so that the general reader can grasp the fundamentals of military strategy and tactics and the relationship of new technical advances in the art of warfare.

No one, even the strongest proponent for the complete utilization of air power, would belittle for a moment the fundamental necessity for well equipped and trained armies to follow the air force and attack demoralized enemy ground forces and occupy conquered areas.

Soldiers will find the book useful in giving them a clear insight into German military doctrine and civilians will receive from it a clearer understanding of current events.

The Art of Modern Warfare, by Hermann Foertsch; Veritas Press, New York, 1940; 265 pages, $2.75.

Practical Manual for Aircraft Shop Workers

During a course of shop training every student takes notes, or should take them. He then has a brief compilation of useful information of an exceedingly diverse character, every item of which has a definite and practical bearing upon his work. It was somewhat in this manner that the "Standard Aircraft Workers' Manual" was developed, which accounts not only for its wide range, but also for its compactness.

Subjects treated include: aluminum alloys for aircraft use, aircraft alloy steel, the most commonly used standard parts, shop hand tools, geometrical layout and construction, shop notes on riveting, bolting and general practice, tables and equivalents, and typical metal aircraft construction and nomenclature.

Accuracy has been achieved through the cooperation of educational directors and engineers from a number of aircraft companies. The book will be of value for study and reference during instruction and also on the job.

Standard Aircraft Workers Manual, Fifth Edition, edited by Stuart Leavell; Fletcher Aircraft Schools, Burbank, 1940; 77 pages, $1.50.

Mrs. Lindbergh Examines the Future

While the word "bomber" is the only aeronautical reference in this essay, the unique position that Mrs. Lindbergh occupies in aeronautics should create an interest in whatever she writes, as her point of view shows the influence of her experiences gained in flights with her husband.

Mrs. Lindbergh gives her interpretation of the bitterness and struggle of our time and concludes that the world is in the process of great change. With lessons before our eyes of the untold misery caused by chaotic uncontrolled upheaval, we owe it to ourselves and to future mankind to preserve the human right to voluntary change.

Man's right to grow and develop and change through the controlled processes of law, of the free ballot, of mutual faith, goodwill and the interplay of free thinking and decision has been flung from the corners of the earth to America, for safe keeping. We must guard it with our strength for future growth in a better world to come. Mrs. Lindbergh voices her faith that the tree of human liberty will be well tended and protected here, and that a better future will surely dawn.

The Wave of the Future, by Anne Morrow Lindbergh; Harcourt, Brace and Company, New York, 1940; 41 pages, $1.00.

The Words We Use

A new dictionary in any field adds to the facility of finding information quickly. In the field of aviation there is an additional problem in keeping reference books as up to date as possible.

The compiler of this dictionary has used the alphabetical arrangement but has divided the nomenclature, terminology and phraseology into special sections so that the specialist will find the terms used in his field grouped together.

The nomenclature of the N.A.C.A. is used as a base, but as this list was prepared several years ago, the additions make the new dictionary of great value for more recent developments. The author had added almost as many new definitions as there were in the N.A.C.A. compilation. The book is an invaluable reference source of recent as well as older words.

In addition to the dictionary there is other technical information, such as a brief chronology of aviation, abbreviations, mathematical constants and conversion tables. In the appendix will be found a list of companies in the aircraft industry, aeronautical schools, and the civil air regulations.

The convenience of the arrangement makes this first edition a valuable addition to any aeronautical library.

Aeronautical Dictionary and Reference Library, by Randolph Hartley, Jr.; DeVorss & Co., Los Angeles, 1940; 524 pages, $5.00.

Arc Welding Discussed in Practical Terms

Arc welding is an important industrial process, and in the final analysis the skill of the welder is an important single element. There is a considerable amount of essential information that he must learn while accumulating experience. Much of that information is contained in the "Arc-Welding Handbook," by Karl Meller. This is intended to give the operator an understanding of the subject in non-technical terms. It will also be useful to foremen, superintendents and small welding-shop owners, who encounter a wide variety of problems.

Electrodes, sources of current, tools and accessories, as well as specific welding jobs and methods are discussed from the practical standpoint. There are tables presenting data on such matters as current, speed, costs (in shillings), and strength. The translation originally appeared in England, and employs British nomenclature.

Arc-Welding Handbook, by Karl Meller; translated from the German by J. E. Webb Ginger; Chemical Publishing Co., New York, 1940; 210 pages, $3.50.

Specifications for Aeronautical Material

A set of specifications of approximately 100 ferrous and non-ferrous aeronautical materials, detailed enough to be used by both aircraft and materials manufacturers, is now available through the efforts of the Aircraft Materials Division of the Standards Committee of the Society of Automotive Engineers. This is the first publication of the division, which was formed to establish standard specifications for the aeronautical industry.

As the amount of information varies with each item, it is not possible to give a general description of the treatment of the subject; but each material is carefully and exhaustively defined. In the preface it is stated that as soon as possible additional sections will be published covering surface protectives, fabrics, and plastics.

This book and the succeeding ones should do much to speed the delivery of materials, as it will be a simple matter to manufacture to a set of specifications which will be standard for the entire aviation industry.

S.A.E. Aeronautical Material Specifications—Section 1; Society of Automotive Engineers, New York, 1940; $3.00 to Members, $6.00 to Non-Members.

Current Status of Aircraft Diesels Reported

Probably the most enthusiastic and persistent American advocate of the use of the Diesel engine in aircraft is Paul H. Wilkinson, the editor of "Diesel Progress," who has not been dismayed by controversy nor discouraged by setbacks. To him, Diesel advantages are too real to be denied, and too great to be neglected.

Diesel-powered airships have been successful; Diesel-powered airplanes are flying today; but most of the current progress is taking place in Germany, though England has made substantial contributions with the Bristol Phoenix. France has been active, and, as is well known, the N.A.C.A. is working with both 2-cycle and 4-cycle test engines. Today's situation of the aircraft Diesel is ably depicted in "Aircraft Diesels," which contains the fruits of Wilkinson's observations abroad in 1939, before the war began, in Germany, France and England, and his knowledge of the present status of the subject in this country.

For the benefit of readers who may not be acquainted with Diesel principles, these are explained, along with a brief history of the engine. The various fuel injection systems are described, and attention is paid to superchargers and engine accessories. Both the 2-cycle and 4-cycle types of engines are included.

Those who are specifically interested in aircraft Diesels will find the story of the development and mass production of the Junkers Jumo Diesel, and also a detailed description of the Jumo 205. Other engines are also described. Wilkinson flew in Diesel-engined planes, and tells about his flights.

The book is partly an excellent technical report, and partly Diesel propaganda. The latter is modestly held back until the later chapters, which discuss economic and mechanical advantages, transoceanic operation, and the future.

In keeping with the factual character of the technical chapters, advocacy of the Diesel is based on facts and figures. For example, it is stated that the 20-passenger Pan American Clippers in service between New York and Lisbon have a maximum payload capacity of 10,000 lbs. when stopping at the Azores for refueling, but only 1060 lbs. for a non-stop flight. Wilkinson states that Diesels of 1500 hp. and weight of 1.30 lbs. per hp. would enable these planes to fly to Lisbon non-stop with a payload of 6880 lbs. The Junkers Jumo 208 would do the job, but neither it nor an equivalent is available in this country. He pleads for a stepping-up of American research and development of aircraft Diesels.

Aircraft Diesels, by Paul H. Wilkinson; Pitman Publishing Corp., New York, 1940; 275 pages, $6.00.

Script of Aviation Radio Drama

There was a stir in non-commercial broadcasting circles following the first radio presentation, on February 19, 1939, of "They Fly Through the Air with the Greatest of Ease." This drama, despite its frivilous title, was and is a powerful indictment of aerial assault upon defenseless civilians, a satirical expression of "the disgust and contempt most of us feel for the fascist conception of warfare."

After having won a prize as an important dramatic work it was printed. The illustrations by Laszlo Matulay took the place of sound effects, not always successfully. The presentation of bombing procedure is technically correct, which is more than can be said for many radio scripts dealing with aviation. Only time will tell whether this attempt at creating a new art form for radio will succeed in introducing literature and radio to each other.

They Fly Through the Air with the Greatest of Ease, by Norman Corwin; Vrest Orton, Weston, Vermont, 1939; 58 pages, $1.50.

Aviation's Aid to the Johnsons

Some of the later motion pictures taken in Africa by Osa and Martin Johnson were made with the aid of two airplanes. Used as a means of transportation, they enabled the couple to make in hours, trips that would have taken them weeks or months on the ground. In Mrs. Johnson's new book, a tribute is paid to their aircraft which also made it possible for them to take some unusual photographs from the air.

The book is a combination autobiography and tale of adventure. Few details of airplane operation are given, the emphasis being upon the many interesting and sometimes dangerous experiences encountered in taking the pictures that have thrilled audiences the world over. Those who have seen and admired the remarkable Johnson pictures will find that the book has everything but motion. The foreword was written by F. Trubee Davison.

I Married Adventure, by Osa Johnson; J. B. Lippincott Co., Philadelphia, 1940; 376 pages, $3.50.

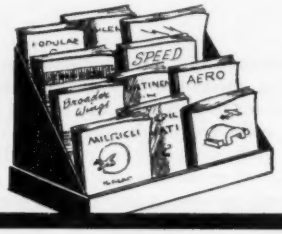
British Airplane Carburetors

Following an introductory chapter dealing with the basic principles of aircraft carburetor design this book deals with descriptions and details of maintenance, repair, and adjustment of Hobson Carburetors as found in the majority of British airplane engines.

While the underlying principles of these carburetors are basically the same, considerable variation in design and construction will be found owing to the wide range of engine types and sizes for which they are designed. Special attention has been given in outlining the correct sequence to be followed when stripping, adjusting, testing, and reassembling the different models.

This book is one of a series of twenty handbooks on airplane maintenance and operation compiled under the general editorship of E. Molloy.

Aeroplane Carburetors (Part I), edited by E. Malloy; Chemical Publishing Co., New York, 1940; 120 pages, $2.00.



Periodicals

The reviews in these pages reflect the statements and opinions of the authors of the articles reviewed, and are not to be taken as editorial expressions of the Aeronautical Review.

Aerodynamics

The Forces on an Aerofoil at Very Low Speeds. A. Thom and P. Swart. Results of experiments measuring lift and drag of an airfoil section in a controlled flow of oil or water. Details of the test equipment are shown and explained and results tabulated. Lift and drag measurements in both oil and water are given for varying angles of incidence. *Journal of the Royal Aeronautical Society*, October 1940, pages 761–770, 12 illus.

Eine Sinfache Methode zur Untersuchung Allgemeinerer Langsbewegnngen eines Flugzenges. (A Simple Method to Investigate the More General Longitudinal Motions of an Airplane.) Chr. Dahmen. Systematic examination of accelerated flight motions for the determination of the dynamic stress of an airplane. The author integrates the equations of the forces of longitudinal motion for a certain type of motion. The results enable him to determine more general longitudinal motions with sufficient accuracy. *Luftfahrtforschung*, August 20, 1940, pages 221–235.

Beitrag zur Aerodynamik der Drehflugelflugzeuge. (Contribution to the Aerodynamics of Rotary Wing Aircraft); Part II. G. Sissing. Based on data previously determined, the most favorable conditions for hovering and for horizontal flight are investigated. *Luftfahrtforschung*, July 20, 1940, pages 196–203.

A Family of Aerofoils With Rounded Trailing Edge. J. C. Cooke. Paper presenting a series of formulas and drawings which describes a family of aerofoils whose members are inverses of ellipses, with rounded trailing edges. *Journal of the Royal Aeronautical Society*, October 1940, pages 771–774, 3 illus.

Zur Anwendung der Ahnlichkeitsmechanik. (On the Application of Mechanical Similitude.) A. Reinhard. The conventional similitude extrapolation into non-dimensional coefficients is explained physically as an extrapolation of the scale into a measuring system relative to a model. The measuring units of this system are derived from the principal magnitudes of the model arrangement in a general prearranged simple manner. The coefficients are complete measuring data in this measuring system, and their measuring figures, being pure figures, are naturally non-dimensional. This measuring method is compared to the relative model scale, conventional in water turbine construction. The author shows how one calculation method may be transposed into the other one. *Luftfahrtforschung*, June 20, 1940, pages 172, 173.

Control-Surface Mass-Balancing. P. B. Walker. Outline and discussion of problems in connection with the full dynamic balancing of control surfaces. General principles are given together with methods for determining both static and dynamic mass balance. *Aircraft Engineering*, October 1940, pages 290–292, 6 illus.

Neues Reibungswiderstandsgesetz fur Glatte Platten. (A New Law on the Functional Resistance of Smooth Plates.) F. Schultz-Grunow. The author using improved measuring methods claims success in developing a new law on the resistance of surfaces which are smooth hydraulically. Tests were also made on airplane surfaces which proved to be hydraulically smooth within the range of the experiments. *Luftfahrtforschung*, August 20, 1940, pages 239–246.

Zur Tragheit von Staudruckanlagen. (On the Inertia of Air Speed Measuring Equipment.) Hans Weidemann, V.D.I. At variations of air speed a certain time elapses until they become visible on the airspeed indicator. This lag is dependent on the dimensions of the pipe line, and on the characteristics of the indicator. In order to compare various air speed measuring equipment, a mathematical expression—pneumatic time constant—is determined, which depends only on the dimensions of the pipe line, and on the indicator. The pneumatic time constant is an indication for the inertia of air speed measuring equipment. *Luftfahrtforschung*, July 20, 1940, pages 211–215.

Aircraft Wing Performance. Raoul J. Hoffman. Analyzing wing performance. *Flying & Popular Aviation*, November 1940, pages 47, 62, 18 illus.

Stromungsaufnahmen eines durch einen Tragflugel Gestorten Schraubenstrahles. (Flow Pictures of the Slipstream of the Propeller Obstructed by a Wing.) I. Flugge-Lotz and K. Solf. The effect of the slipstream of the propeller is not yet sufficiently known. For further research the authors made tank tests which are described in detail showing the testing arrangement for the following: (1) Slipstream of the propeller without the interfering wing, (2) effect of the angle of incidence, (3) effect of the depth of the wing, (4) effect of the angle between propeller axis and wing chord, (5) effect of the distance between propeller axis and wing chord, (6) effect of drift, (7) effect of the distance between propeller axis and wing chord on a crabbing airplane, (8) effect of a strong interference at the wing. *Luftfahrtforschung*, June 20, 1940, pages 161–166.

The Fixed Leading Edge Slot and Aileron Control (Part I). Dr. Alexander Klemin. Summary of results of wind tunnel tests carried out at New York University by graduate students. Part I discusses the rectangular wing and the effects of a leading edge slot on the characteristics of the N.A.C.A. 23012 airfoil, as a result of investigations by Thomas B. Woersching. Tests were conducted on three types of slot used by Lockheed, Stinson and Fairchild, respectively. Results are given in graph form. *Aero Digest*, November 1940, pages 108, 111, 112, 13 illus.

Graphische Konstruction von Sturzfluggeschwindigkeiten. (Graphic Construction of Diving Speeds.) Hermann Behrlohm. (Report of the Messerschmitt Company.) A quick graphic method has been developed to determine the flying speed reached when starting from any assumed altitude and any assumed initial speed to any assumed final altitude in a vertical dive (or in a glide at a constant angle

of inclination of the path). *Luftfahrtforschung*, June 20, 1940, pages 167–171.

Ebene Potentialstromung langs einer glatten Wand mit stuckweise stetiger Krummung. (Even Potential Flow Along a Smooth Wall Whose Curvature Is Partially Continuous.) Werner von Koppenfels. Wind tunnel tests on airfoils which have a continuous tangent course, but have an abrupt bend at one point of their outer surface, not far from the nose, show an unsatisfactory aerodynamic action. The article discusses this effect in detail. *Luftfahrtforschung*, July 20, 1940, pages 189–195.

Experimentacian de Cascos y Flotadores de Hidroaviones. (Tests on Flying Boat Hulls and Seaplane Floats.) Felipe Lafita Babio. Detailed description and comparison of results of tests made in full scale and on model seaplane floats and flying boat hulls. *Aeronautica Argentina*, April–June 1940, pages 1776–1781.

The Guidonia High-Speed Tunnel. A. Ferri. Description of this Italian wind tunnel built for research in supersonic speeds. Designed as a continuous flow tunnel rather than the discontinuous compressed air type, its circuit comprises compressor, cooler, test chamber and return conduit. The compressor is driven by a 6000 volt motor developing 2850 hp. Details of the entire installation are shown. *Aircraft Engineering*, October 1940, pages 302–305, 12 illus.

Airplane Descriptions

The Focke-Wulf Family. Specifications of various Focke-Wulf warplanes in use by the Nazis. *The Aeroplane*, September 20, 1940, pages 324–325, 4 illus.

The Messerschmitt Me-110. Latest German twin engined fighter is examined by the staff of *Flight*. The Me-110 can also be adapted for use as a bomber, the bomber model being known as the Jaguar. In performance, the Me-110 is nearly as good as it looks and even the British admit that aerodynamically it is very clean. One of the features shown is the machine gun housing in the nose, the top of which lifts up and back very much like the hoods of recent model American cars. Other details of equipment and armament are also given. *Flight*, October 10, 1940, pages 307–310, 8 illus.

The Sportsman Test Pilot. James B. Taylor, Jr. Powered with a Continental 75 hp. engine, the Culver Cadet cruises at 120 m.p.h., has a stalling speed of 45 m.p.h., a useful load of 585 lbs., and a range of 600 miles on 20 gallons of gasoline. Notes on construction and flight characteristics are given by the author. *The Sportsman Pilot*, October 15, 1940, pages 14, 15, 30, 4 illus.

The Messerschmitt Me-110. Armed with four machine guns and two 20-mm. cannon, with a speed of 365 m.p.h. at 19,000 ft., the Messerschmitt Me-110 is the fastest, most heavily armed and maneuverable fighting airplane that Germany has produced, according to this British analysis. Details and pictures of armament, engines, interior arrangement and equipment, and complete performance specifications are given. *The Aeroplane*, October 11, 1940, pages 406, 407, 9 illus.

The Junkers Ju-88-A1. Since the first Junkers Ju-88 made such impressive speed with load records in 1938, so many changes have been made as military afterthoughts that the present version as a military weapon is far less formidable than the British High Command expected from advance reports. According to the writer, study of the Ju-88s shot down in Britain show that changes made in design to enable them to be used in dive bombing have lessened their speed considerably. Structural details are shown and performance figures cited to show that present models are not up to performance standards of the original. *The Aeroplane*, October 11, 1940, pages 408, 409, 10 illus.

The Heinkel He-111K (Series H). Although the first He-111s went into service in 1935, the modern version known as the He-111K Series H, redesigned to take engines of double the original horsepower, is still in production. A British account of its features of design and construction. *The Aeroplane*, October 11, 1940, pages 410, 411, 9 illus.

Boeings for Britain? Analysis of design, range and armament of the Boeing Flying Fortress, as applied to possible use for long range bombing by the R.A.F. *The Aeroplane*, September 27, 1940, page 351, 2 illus.

The Latest Deck-Lander. Performance notes and estimates on the new Vought-Sikorsky XF4U-1 fighter developed for the U.S. Navy. Said to be in the 430 m.p.h. class, the new inverted low gull wing monoplane is powered with an 18 cylinder Pratt and Whitney radial engine rated at 1850 hp. for take-off and 1600 at an altitude greater than 20,000 ft. *Flight*, September 19, 1940, page 233, 1 illus.

An Inferior Product—the Me-109. Point by point structural and design analysis of one of the many Me-109s brought down by the R.A.F. Product of the Nazi Erla Shadow factory and dated June 27, 1939, the machine bears the serial number 1394 from a plant entering its fourth year of production. Engine and mounting, instrument equipment, control surfaces are described. *The Aeroplane*, October 4, 1940, pages 372, 373, 8 illus.

Germany's Dive Bomber. The Junkers Ju-87 gull wing dive bomber is the best known and most widely used thus far in the war. However, they were quickly proven obsolete when they encountered the later British fighters. Performance and structural details are given, together with an analysis of present military value of this veteran model. *Flight*, October 17, 1940, pages 322–324, 5 illus.

The Lockheed P-38. With a top speed approaching 500 m.p.h. the new Lockheed P-38 is undergoing test flights at Burbank, California. The P-38 is an improved model of last year's XP-38 which cruised across the United States in 7 hours and 45 minutes. Britain has 800 of the new interceptors on order. They will probably be made into two-seater fighters with a gun turret aft and equipped with Rolls-Royce Merlin engines. Present armament includes two 0.50 calibre machine guns, two 0.30 calibre machine guns and a 23 mm. cannon, all firing from the nose. *Commercial Aviation*, October 1940, pages 38–40, 5 illus.

Lycoming-Powered Funk Model L. Construction and performance of a new 2S class airplane powered by a 75 hp.-dual ignition Lycoming. Seating is side-by-side and standard equipment includes dual wheel controls, brakes, parking brake, cabin heater and soundproofing. Structural details and performance specifications are also given. *Aero Digest*, November 1940, page 162, 2 illus.

Modern German Bomber. A detailed description of the Junkers Ju-88, a large number of which have been brought down by the Royal Air Force since the type first appeared over England this spring.

Comments, many of them favorable, on structure, design and material are made on this ship. Such details as the ball and joint fittings, engine installation, propeller and deicing equipment are completely described. *Flight*, October 3, 1940, pages 269–271, 7 illus.

Airports

Congress Votes $40,000,000 for Building 250 Airports. Digest of recent Congressional action on the Airport section of the Civil Functions Appropriations Bill. *American Aviation*, October 15, 1940, pages 1, 10.

More Fun at the Airport. William D. Strohmeier. With costs of modern lightplanes lower and their power, design and equipment improved each year, airplanes are attracting more and more potential owners who return to their country clubs and yacht clubs

because of the dingy makeshift aspects of many airports with their lack of social facilities. Here are plans for a modest airport clubhouse which can turn an airport into an aviation country club and at the same time give better office and control facilities for the local operator. *Aviation*, November 1940, pages 38, 39, 106, 4 illus.

Regarding Traffic Control for Non-Scheduled Aircraft. James B. Taylor, Jr. Increased traffic in the vicinity of airports has created serious traffic problems. This calls for better traffic manners on the part of pilots and better traffic techniques in congested areas. Of especial value is a taxi strip running completely around the field and rules governing its use as developed at Correy Field, Pensacola, Florida. *The Sportsman Pilot*, October 15, pages 13, 37, 38.

Battle of the Airports. Outline of Canada's tremendous problem of winter maintenance of military and commercial airports. Heretofore compaction has been used which merely means that the snow is smoothed, rolled and packed down into a snow pavement after each successive fall. Spring thaws often render such fields useless by alternate melting and freezing. This year more rotary blowers will be used to completely clear runways of snow in much the same way that snow removal is handled by the street cleaning departments of large cities. *Commercial Aviation*, October 1940, pages 30–32, 7 illus.

N.A.S.A.O. Criticizes Curtailment of Civil Aviation on Airports. The National Association of State Aviation Officials at its recent convention in Louisville, Kentucky, urged the Government to establish enough military air bases of its own to avoid having to take over any more civil airports, and to return to civilian use those airports which it has already taken. The N.A.S.A.O. also went on record as favoring a separate and distinct air force with cabinet representation, and the raising of the pilot age limit of the present C.P.T.S. *American Aviation*, November 1, 1940, pages 1, 15.

Not Enough Airports. Gill Robb Wilson, President, N.A.A. Details of the long range plan of the C.A.A. for building more airports. The $80,000,000 approved in September by the Budget Bureau covers only a small fraction of the C.A.A. program which calls for the expenditure of $560,000,000 over a period of three years. *Southern Flight*, October 1940, pages 10, 11.

Transatlantic Seaplane Base, Baltimore, Md. W. Watters Pagon. Mud fill having been used for the Municipal Airport at Baltimore, difficult foundation conditions were encountered, reflected in the design and construction of the steel hangar and brick office building now leased to Pan American Airways. There is a history of the airport, a report of the conditions found, and details of the construction. *Proceedings, American Society of Civil Engineers*, October 1940, pages 1469–1489, 13 illus.

Spotlight on Airport Planning, by A. B. Wescott. Recently enacted federal legislation for a nationwide program of airport construction and expansion focuses attention upon Los Angeles County's master plan of airports. *Western Flying*, October 1940, pages 20, 21, 30, 32, 2 illus.

National Airport. With 90 percent of the runways completed, President Roosevelt laid the cornerstone of the terminal building at the Washington National Airport. A complete description of the new super-airport for the nation's capital, including buildings, transportation and handling facilities, ground traffic approaches and air traffic equipment. *Civil Aeronautics Journal*, October 15, 1940, pages 446, 447, 458.

Air Transport

Pan American's Strato-Clipper Cruises to South America. New cruise rates to Rio de Janeiro, at a saving of 32 percent over regular round-trip fares and the usual travel expense were inaugurated by Pan American on October 2. All-inclusive prices as low as $650 for an eleven-day cruise are expected to increase travel to South America for business and pleasure by three to four hundred percent. Prices, route and details of several different cruises are given. *Aero Digest*, November 1940, pages 58, 61, 4 illus.

A New Ambulance Plane. Knut Gumerfeldt. Detailed description of a new ambulance plane built for Sweden by the Beech Aircraft Corporation. Its all-around efficiency is more than twice that of types used up to now. *Flying*, August 1940, pages 8, 9, 5 illus.

Midway—The North Pacific's Tiny Pet. Homer C. Votaw. History of this pin point of an island in the Pacific with its amazing number of shipwrecks and castaways. Now it is an important stopover on the Pan American air route to the Far East, and is rapidly becoming an important defense outpost for the United States. *U.S. Naval Institute Proceedings*, November 1940, pages 1598–1607, 3 illus.

Sailors of the Sky. How a transatlantic Clipper is flown to Europe on schedule, with a description of crew personnel and the duties of each member. Captains of the Clippers hold the highest rank attainable by commercial pilots anywhere in the world—that of Master of Ocean Flying Boats. Four pilot officers besides the Captain are carried and their time is divided between the duties of piloting and navigation. Duties of engineer and radio officers are also described. *Popular Mechanics*, December 1940, pages 866–869, 141A, 142A, 11 illus.

Skyways Progress. Ellen Huntington. Report of new routes and airports in the United States. *Airlanes*, October 1940, pages 8, 9, 18, 8 illus.

Aviation's Broadening Markets. Selig Altchul. Discussion of potential markets for aviation, including development of freight service and freight carrying transports, standardization of British and American airplane designs to speed warplane production, effect of the five-year amortization provision in the Excess Profits Tax Bill of 1940, and gains shown in airline mail revenues. *Aviation*, November 1940, pages 47, 110.

Airlines News Theatre. Ray L. Hall. Passengers in New York's Airline Terminal will be able to enjoy the convenience and luxury of their own news reel theater, which is to be part of the facilities of the new "Grand Central" of the airlines. *Airlanes*, October 1940, pages 7, 15, 1 illus.

Air Travel Panorama. W. A. Brenard. British description of the good old days before the War when British passenger planes left Croyden for distant airports of the Empire and the world. *Aeronautics*, October 1940, pages 30–32, 7 illus.

Armament

The Cannons Are Coming. Squadron Leader C. A. Rea. Early experiences in the development of aircraft cannon. *Aeronautics*, October 1940, pages 60–62, 1 illus.

Armor for the Eagle. Arch Whitehouse. Uncle Sam's special armor for new warplanes is a secret as closely guarded as the now famous mystery bombsight. *Air Trails*, October 1940, pages 17, 49, 50, 4 illus.

Some Enemy Observations on the Armament of Allied Aircraft. H. J. A. Wilson. Review of a German analysis of allied aircraft shot down in the first six months of the war. *Aeronautics*, October 1940, pages 43, 44, 4 illus.

Biography

Silhouette. Account of the remarkable career of Jacqueline Cochran, who was recently awarded, for the third consecutive year, the International League of Aviators trophy as the world's outstanding woman pilot.

Her log is a record of achievement sandwiched in between stretches of hard and careful study, preparation and endless hours of practice. *The Sportsman Pilot*, October 15, 1940, pages 24, 34–36, 3 illus.

The Pugnacious Spirit. Notes on the career and policies of Air Marshal Sir Charles Portal, Britain's new Chief of the Air Staff. An advocate of the offensive defense of continuous bombing his appointment portends more of the large scale bombing operations he has carried out as commander of the bomber forces. *The Aeroplane*, October 11, 1940, page 390, 1 illus.

The Career of Donald W. Douglas. A cartoon-type picture and caption story showing highlights in the career of Donald Douglas. *Popular Science*, December 1940, pages 126, 127, 10 illus.

"Bob" Gross. A one-page biography of Robert E. Gross, President and Treasurer of the Lockheed Aircraft Corporation. *Western Flying*, October 1940, page 26, 1 illus.

Biography of Air Chief Marshal Sir Frederick William Bowhill. Caricature by Bruce Angrave. *Aeronautics*, October 1940, page 45.

Business and Finance

Aviation's Economic Problems. Economist. A discussion of present and future export trade conditions in aviation. *Aeronautics*, October 1940, pages 73, 74.

Making Hay. Trade development in general and of aviation in particular with the nations of South America is urged and problems outlined of present and future trade and cultural relations. The writer believes that a realistic survey should be made and immediate constructive action taken. *American Aviation*, November 1, 1940, pages 1, 16.

Tomorrow's Export War. James Bassett. The War in Europe gives the American aircraft industry a fine opportunity in foreign markets all over the world. But it should prepare now for keen competition ahead. *Air Trails*, October 1940, pages 18, 19, 51–53, 7 illus.

Design

Terminal Velocity Dives. Brian Worley. An engineer's analysis of the ultimate speed modern aircraft can attain in a dive. *Aeronautics*, October 1940, pages 34–36, 5 illus.

Design Possibilities of Long-Range Civil Aircraft. H. Roxbee Cox. An excellent digest of the 1940 Wilbur Wright memorial lecture, giving an analysis of design factors in planning the airliners of the future. Fuselage airplanes *versus* giant flying wings, combination fuselage and flying wing landplanes are compared with hundred ton flying boats, yet the whole presentation is kept strictly to the limits of practical design by means of graphs showing comparisons of speeds, load limits, space limits, and comparative performance of the different forms under discussion. *Aero Digest*, November 1940, pages 149, 150, 153, 154, 157, 158, 12 illus.

The Case for the Single Bladed Rotor. J. Lauderdale. Suggestions for the design of a high speed single rotor autogyro which would combine the slow landing and steep take-off characteristics of the autogyro with the high speed flight of the fixed wing airplane. A retractable mounting would permit the rotor to be used on take-offs and landings. In flight, the rotor would be stopped and secured to the fuselage. *Flight*, October 3, 1940, pages 275–277, 7 illus.

Probing German Secrets. Engineering details and sketches of design features found in German warplanes shot down over England. The Messerschmitt Me-110's new wing radiator and air intake, details of gun housing and gun mountings in the nose, and the after-cockpit cover assembly, are shown together with drawings of Junkers Ju-88 dive brakes, flap fairing, interior layout and construction of fiber and rubber gas tanks. *The Aeroplane*, October 11, 1940, pages 403–405, 12 illus.

Aviation Sketch Book of Design Detail. This month's items include flaps on the Curtiss-Wright transport, wheel and landing gear of the Martin Bomber, engine mounts of the Messerschmitt Me-109 and the British Hawker Hurricane, and the bomb bay doors of the Vickers Wellington Bomber. *Aviation*, November 1940, pages 58, 59, 5 illus.

It Isn't in the Book. Engineering details of a diagonally ribbed wing as used in the new Erco lightplane. The design shows a light, simple and inexpensive wing of all metal construction with the exception of its fabric covering. *Aviation*, November 1940, page 61, 3 illus.

Aircraft Design

Flight Load Factors. Text of Report No. 6, History, Gusts, Large Airplanes. A review of the background upon which present load factor requirements are based together with a discussion of present C.A.A. requirements, and the possibility that maneuvering load factor requirements for large airplanes may be revised, to more fully cover maneuvering loads and gust acceleration loads of large, high-speed airplanes in rough air. *Civil Aeronautics Journal*, October 1, 1940, pages 438–442, 444, 9 illus.

Rebuke to Science. Marc Hanlon. This is the story of a famous patent. In 1876 Alphonse Penaud and Paul Gauchot were granted patent rights on their design for an airplane which incorporated full cantilever wings of stressed skin construction; retracting tricycle landing gear with shock absorbers; controllable pitch propellers of opposite rotation; engines streamlined into the wing; and an automatic pilot and artificial horizon. It treated of washout of the wing tip; tapered wings; glass cockpit cowling, and amphibian operation. It had almost everything except a method of maintaining stability. *Western Flying*, October 1940, pages 17, 19, 28, 30, 2 illus.

Development

The Airplane Laboratory and National Defense. Brief text and numerous pictures showing the work and equipment of the laboratory at the factory of the Bell Aircraft Corp. *Metals and Alloys*, October 1940, pages 451–454, 10 illus.

The Need for Research. Charioteer. Scanning the research objectives needed to maintain superiority of British aircraft. *The Aeroplane*, September 20, 1940, page 317.

Engineering Laboratory of the Bell Aircraft Corp. Robert C. Woods. A member of the laboratory takes the reader on a personally conducted tour of inspection. Various departments and their activities are explained, and the importance of research analyzed for the general reader. *Aero Digest*, November 1940, pages 124–126, 191, 11 illus.

Research. William B. Stout. Aviation alone has maintained the rapid progress in development and engineering so vital to the welfare of the nation. The author believes that only through a vast increase in research on the part of all industry can this nation grow and survive. *Aero Digest*, November 1940, page 161, 1 illus.

Engines

Aircraft Engine Reduction Gears and Torque Meters. Roland Chilton. A discussion of the growing need for and various types of reduction gears, with emphasis on the performance of those developed by the Wright Company. Abstract from S.A.E. preprint for National Aircraft Production Meeting. *Aero Digest*, November 1940, pages 142, 1 illus.

Methods of Preventing Carburetor Air Intake Icing. Suggestions by the Certificate and Inspection Division of the Civil Aeronautics Authority for

preventing the formation of ice in engine carburetors, with regulations governing minimum heat rise on various types of carburetor and test methods by which heat rise is determined. *Aero Digest*, November 1940, pages 116, 121, 1 illus.

Baked Engines. Howard Waldorf. 75 percent of the machine work, all foundry operations, 66 percent reduction in manufacturing costs, 200 to 300 engines per day production from the average machine shop, weight of less than 1 lb. per hp., are among the claims in behalf of an engine and its production process recently perfected by Lloyd M. Taylor and George A. Selig, two west coast airplane mechanics. The engine is of fabricated steel, literally a cut and paste job. The crankcase, cylinder block, cylinders, and cooling jacket are stamped out of light weight high-tensile strength aircraft steel, assembled, put into a copper brazing furnace and are completely and permanently bonded in a single operation. *Flying and Popular Aviation*, November 1940, pages 27, 28, 4 illus.

The Story of Solar. T. G. Armstrong. Seven years passed before the five thousandth engine manifold came off the assembly line of the Solar Aircraft Company, San Diego, Calif. The second five thousand have been turned out in 18 months. Present bookings call for deliveries of 150,000 units per month. *Southern Flight*, October 1940, pages 6, 7, 6 illus.

Italian Air-Cooled Engines. Paul H. Wilkinson. Details of the following: Isotta Fraschini Delta RC 35 IDS, a twelve cylinder inverted V engine; Alfa Romeo, a 1500 hp. radial; Fiat A 82 RC 42, a 1400 hp. radial; Fiat A 80 RC 41, a 1000 hp. radial; Piaggio P XII RC 35, a 1500 hp. radial; and the Piaggio P XI RC 40, rated at 1000 hp. It is stated that Alfa Romeo, Fiat and Piaggio are developing twin row radials of 2000 hp. *Aviation*, November 1940, pages 72, 73, 2 illus.

Italian and French Lightplane Engines. Specifications of two air-cooled four-cylinder lightplane engines. The C.N.A.D., a 60 hp. Italian engine and the AVA 4 A-00, a French two-stroke engine of 25 hp. *Aviation*, November 1940, pages 68, 122, 126, 2 illus.

Streamline Motors for Streamline Warplanes. Condensed from *Fortune*, July 1940. Story of the Allison liquid-cooled airplane engine as used in several leading types of American military aircraft, including the Bell Airacobra and Airacuda, the Curtiss P-40 and the Lockheed P-38. *Popular Science*, December 1940, pages 62–65, 7 illus.

Single Stage Superchargers. Dr.-Ing. K. Kollman. Factors limiting the performance of single stage superchargers are treated under the following heads: (1) construction material of the impeller, (2) aerodynamic considerations of design (special impeller intake sections, double shrouded impellers, special vanes) to increase efficiency, (3) construction considerations, (4) impeller shaft bearing limits, (5) supercharger drive (gears, couplings, clutches and gear boxes), and necessity for variable gear ratios. Characteristic curves of various superchargers are given together with a graph showing the interrelationship between the characteristics of centrifugal superchargers. *Aircraft Engineering*, October 1940, pages 298–301, 306, 13 illus. Also *Journal of the Royal Aeronautical Society*, October 1940, pages 775–790, 17 illus.

Return of the Oilburner. Lawrence Ward. New aircraft Diesels soon may be available in quantity, as production of its counterpart for new army tanks is begun by the Buda Company of Harvey, Illinois. *Flying and Popular Aviation*, November 1940, pages 36–38, 60, 6 illus.

The Performance of Modern Aircraft Diesels. Paul H. Wilkinson. The author, who visited Diesel aircraft centers in Germany, France, England and the United States, gives a first-hand report on the merits of the latest aircraft Diesels. Photographs and performance figures of the better known makes and models are shown and compared to gasoline engines of comparable size and horsepower. *S.A.E. Journal*, November 1940, pages 474–479, 10 illus.

Engine for Light Planes Weighs 130 Pounds. Brief description of a two-cylinder air-cooled engine, rated at 75 hp., developed by Julius Dusevoir of San Leandro, Calif. *Popular Science*, December 1940, page 67, 1 illus.

Advantages of the Two Cycle Engine. E. W. Roberts. Comparison of the two cycle with the four cycle engine. The author, a specialist on two cycle engines, outlines certain points of design which he maintains will enable engine designers to perfect a two cycle aircraft engine which will practically double the power of a four cycle engine of the same piston displacement and r.p.m. *Aero Digest*, November 1940, pages 145, 146, 1 illus.

The Lenape 5-Cylinder "Brave." Edwin H. White. Notes on the construction and performance of a new 5-cylinder 95-hp. radial engine for lightplanes. *Aero Digest*, November 1940, pages 165, 166, 188, 13 illus.

Supercharged Aircraft Ignition Harness. Carl E. Swanson. An analysis of ignition harness failures caused chiefly by (a) entry into the harness of moisture, anti-icer fluid and oils, (b) origination of electrical corona due to electrical and chemical action which takes place within the shielding, (c) impurities entering the ignition system from the combustion chamber through spark plug core leakage. The supercharged harness, as an answer to these troubles, is then described by the author who is responsible for its development. Abstract from S.A.E. Preprint for National Aircraft Production Meeting. *Aero Digest*, November 1940, pages 141, 142.

TWA Re-equips with 1200 hp. Cyclones; Stratoliners' First Flights Shatter Records. Transcontinental and Western Air re-equipped not only its new Boeing Stratoliners with the 1200 hp. G-200 Cyclones but is gradually installing these larger units in their fleet of DC-3's. The additional 200 hp. per engine enabled the four engined Boeings to lower the transcontinental passenger time to 15 hours and 35 minutes on a special trip and is speeding up service on the route. *Trade Winds*, October 1940, pages 4, 5, 3 illus.

Factory Equipment

Plant Lubrication. With back pressures on shafts and bearings of 4000 to 5000 lbs per sq. in. power and hydraulic presses require special lubricants and lubricating methods. Different lubricating systems for metal forming presses are described and compared. *Aircraft Production*, October 1940, pages 337, 338.

CO_2—An Answer to Fire Hazard. C. L. Griffin. Increased use of automatic detectors and clouds of carbon dioxide gas shot from high-pressure cylinders protects airplanes and airplane plants where the widespread use of highly volatile inflammable liquids makes fire hazard doubly acute. *Western Flying*, October 1940, pages 15, 16, 3 illus.

German Production Equipment. Dipl.-Ing. K. Frydag. Notes on the development of special machine tools for the mass production of all-metal aircraft, especially those pioneered by the Henschel Flugzeugwerke A.G. which are now widely used by aircraft manufacturers everywhere. These include stretching presses, special light drop hammers, fully automatic riveting machines, different types of hydraulic presses, as well as various milling and bending machines. The chief difference between automotive and aircraft machine tools is that the former can be created, used, scrapped,

and charged off to the hundreds of thousands of identical units it produces, while aircraft machine tools must be adaptable to smaller runs of different parts. *Aircraft Engineering*, October 1940, pages 314, 315, 317, 17 illus.

A New British Milling Machine. Details and specifications of the new Wickman-Hollroyd spar-boom horizontal milling machine. Diagrammatic drawings are given, showing three types of the same machine which can be used as a plain single spindle machine, as a single spindle miller with vertical in-feed to the cutter, and as a duplex horizontal milling machine. *Aircraft Engineering*, October 1940, pages 309, 310, 6 illus.

Modern Machine Tools. Latest models of the British machine tool industry presented with performance data and illustrations. *Aircraft Production*, October 1940, pages 326–328, 9 illus.

Milling Wing Spars. A review of spar milling machines as offered by British machine tool manufacturers. *Aircraft Production*, October 1940, pages 339–341, 8 illus.

Shop Equipment and Small Tools. Shop equipment and production aids offered by British makers. These include a new portable flush riveter, an improved materials gage, an optical division tester, a bench type engraving machine, a high-speed fixed base riveter, a jack skate mounted on roller casters which fits an airplane wheel used to facilitate handling of aircraft during final assembly. *Aircraft Production*, October 1940, pages 334, 335, 6 illus.

Flight Testing

Nullschub-Anzeigegerat und Ruderblockierung, Zwei Neus Hilpmittel fur Flugmessungen. (Zero Thrust Indicator, and Lock for the Control Surface, Two New Auxiliary Devices for Flight Measurements.) W. Stiess. (Report of the Dornier Works G.M.B.H.) Flight testing technique requires measuring instruments which occasionally differ from those used in the laboratory. Some of these have been developed during the past few years. At the same time, new types of testing equipment are being found necessary to produce flight conditions which are essential for certain test measurements. The author describes the two auxiliary devices, which have worked very satisfactorily. *Luftfahrtforschung*, August 20, 1940, pages 236–238.

Fuels and Lubricants

Oil for Aviation. Assen Jordanoff. The what, why, and how of oil and gasoline for aviation use. The author, an expert at simplifying technical subjects in aviation for the student or beginner, discusses oil viscosities, structure, flashpoint and lubricating functions in the airplane engine, and concludes with a similar analysis of aviation gasoline. *Canadian Aviation*, October 1940, pages 36–39, 24 illus.

Gliding and Soaring

Soaring Show. Alexis Dawydoff. News, camera studies, and the contest log of the 1940 National Soaring Meet at Elmira, N. Y. *Air Trails*, October 1940, pages 26, 27, 58, 59, 16 illus.

Why No Gliding Sports in Dutch East India? The article expresses surprise that so little has been done in Dutch East India relative to gliding. Although the country is ideal and there are means for the support of gliding, its comparatively few devotees are to be found mostly among the Japanese. *Luchtvaart*, September 3, 1940, pages 330, 331.

It Takes Pull! Alexis Dawydoff. A discussion of different methods of launching gliders, with data on launching equipment and correct launching speeds. *Air Trails*, December 1940, pages 20, 60–62, 5 illus.

Gliding at Dalarna. Various glider types are described and shown in photographs together with successful pilots and their classification. The article stresses the progress made in training at this camp site. *Flygning*, August 1940, pages 13, 19, 5 illus.

History

Christmas Aileron Claim Challenged. J. A. D. McCurdy. Reply of a famous Canadian pioneer pilot to the statement in the August issue of *Canadian Aviation* that ailerons were invented and first used by Dr. Christmas, an American. According to the author ailerons were patented in 1909 by the Aerial Experiment Association, of which Glenn H. Curtiss was a member, and were Canada's most important contribution to aviation. *Canadian Aviation*, October 1940, page 30, 1 illus.

The First Air Attack. During the siege of Venice, the Austrians made the first air attack in military annals. They used 200 small balloons to each of which a 30 lb. long-fused bomb was attached. On June 22, 1849, the wind was favorable, its direction being straight toward the forts of Venice. The fuses were lit and the balloons ascended. The length of the fuses had been accurately calculated so as to explode the bombs above the Venetian forts. However, as the balloons neared the forts, the wind changed suddenly and drove the balloons back toward the lines of the Austrians, who fled in panic. *Luchtvaart*, September 3, 1940, page 337.

Flying, as It Was. Edwin C. Parsons. Author's experiences flying for Villa in 1913. The condition of his much patched Curtiss having cured his Mexican Officer students before they began flight instruction, he and a companion, Jeff de Villa, later made many scouting flights for Villa and ended their engagement by taking off from an 8250 ft. plateau in a plane whose absolute ceiling was 5000 ft. *The Sportsman Pilot*, October 15, 1940, pages 16, 30, 32.

An Industrial Portrait. Selby Calkins. The story of the great Consolidated Aircraft plant, which is really the biography of Major Reuben Hollis Fleet, began in the post war days, when the old Gallaudet plant in East Greenwich, R. I., shared its airplane manufacturing space with the production of featherboards for cotton bolts.

The first job was rebuilding DH's for the Army. Fleet's first contract for fifty new Army training airplanes necessitated moving the plant to Buffalo. When flying boat construction was begun, Consolidated Aircraft moved to the Pacific Coast so that the flying dreadnaughts might be tested under salt water conditions. How the plant, Major Fleet's dream, has grown since the featherboard days is best shown by the huge factory at Lindbergh Field at San Diego. *Western Flying*, October 1940, pages 12, 14, 28, 3 illus.

Instruction

So They Want 100,000 Pilots. M. V. Gibbons. Pittsburgh's community program of pilot training was launched when Graham Aviation, Inc., C.A.B. approved flight and ground school, offered a free course in ground instruction to anyone interested in aviation. The Aero Club of Pittsburgh contributed six solo license scholarships to highest scoring students and 1200 potential pilots took the course. The story and details of the project are given. *Flying & Popular Aviation*, November 1940, pages 21, 64, 66, 1 illus.

Youth Takes Wing. Douglas J. Ingells, with assistance of Prof. Roland H. Spaulding. Twin objectives of Uncle Sam's Civilian Pilot Training Program are (1) to create a reserve pool of trained pilots for war-time emergency, and (2) to prevent the bottleneck threatened by the industry's ability to turn out far more planes in peacetime than there are pilots to fly them. *Model Airplane News*, November 1940, pages 8, 9, 48, 50, 52, 16 illus.

Timing the Turn. John R. Hoyt. Applying the laws of motion and the mathematics of flight to figure (1) degrees of bank, (2) time required to make 360 degree turns, or (3) speed in turns. Given any two, the remaining factors can be figured. *Aero Digest*, November 1940, pages 46, 49, 5 illus.

Training Center at Hemet for Army Air Corps Cadets. Capt. Lloyd P. Hopwood. Account of the choice of location, building, organizing and putting into operation of a new primary training school for Air Corps Cadets. Hemet is a branch of the Ryan School which can train 125 cadets. A ten-week course is given with provision for graduating half the normal cadet complement every five weeks. *Aero Digest*, November 1940, pages 42–44, 158, 7 illus.

Yanks For Canada. Edward Churchill. American pilots with 500 hours, plus instrument rating are being sought by the R.C.A.F. as instructors in Canada's rapidly expanding air training program. *Flying and Popular Aviation*, November 1940, pages 34, 35, 79, 3 illus.

Bomb Box. Pictures and captions showing the miniature bomb range for student instruction at Kelly Field, Texas. *Air Trails*, December 1940, page 21, 6 illus.

Air Corps Questionnaire. Series of questions and answers about qualifications and requirements necessary to become a flying cadet in the Army Air Corps. Age limits, educational requirements, marriage requirements, and physical examination details are given, together with questions about the Service and its training periods and equipment. *Air Trails*, December 1940, pages 12, 13, 62–64, 2 illus.

Break Formation! James L. H. Peck. An elementary lesson in organization of combat units in the Air Corps, and the use of tactical flight formations. *Air Trails*, December 1940, pages 14, 15, 52, 5 illus.

Engineering Made Easy. Peter Bowers. The author upon entering the Boeing School of Aeronautics has found that his long experience as a model builder gives him a definite advantage in his engineering studies. *Air Trails*, December 1940, pages 18, 46, 3 illus.

Navy Pilot Mill. John R. Hoyt. From 22 to 1600 pilots per month is the Navy's program of increased pilot training, which will be handled largely through Naval Reserve Air Bases. Here is an account of the entire plan of training including requirements, period of enlistment, ground school and flight curriculum. *Air Trails*, December 1940, pages 8, 9, 56–58, 7 illus.

The Throttle or the Brake. Robert E. Gross. Several suggestions for speeding up production of Military Aircraft include, simplification of Government purchasing methods and contracts, less rigidity in Army and Navy tolerances and specifications, and above all efficient mass training of aircraft production manpower by the industry. *Airlanes*, October 1940, pages 2, 3, 21, 23, 1 illus.

Wanted: Trained Aviation Workers. Dean Brossman. Aviation's manpower shortage is in professional and skilled labor only. Competition for unskilled labor is tremendous, but a very real shortage exists in skilled machinists and machine operators, engine designers, draftsmen and development men experienced in drafting work on engines. Sales and distribution problems are practically nonexistent. Included is a short index of available jobs and several rules for job seekers. *Air Youth Horizons*, October 1940, pages 1, 8, 1 illus.

New Texts Prepared for C.P.T.P. Ten new training manuals for students and instructors have been announced for the Civilian Pilot Training Program. They include a revised Flight Instructor's Manual, Digest of Civil Air Regulations for Pilots, Civil Pilot Training Manual, Practical Air Navigation, Meteorology for Pilots, Aerodynamics for Pilots, Pilot's Airplane Manual, Pilot's Powerplant Manual, Pilot's Radio Manual, Ground Instructor's Manual. Distribution is scheduled to begin this month. *Civil Aeronautics Journal*, October 15, 1940, page 451.

How Aircraft Factories Find Their Men. Charles F. McReynolds. 30,000 aircraft workers have been absorbed into Southern California aircraft plants in the past year. Where they come from, how they are trained is described by the author as he points out that the industry in Southern California has already solved most of its problems of personnel procurement. The answer has been found in a tremendous and speedily efficient program of employee education and training. *Aviation*, November 1940, pages 32, 33, 112, 114, 2 illus.

The Performance Division. W. G. Stewart. Performance Division of the Civil Pilot Training Service is in charge of planning, contracts, control, analysis of results, and research into training methods, in a word the paper work of the C.P.T.S. Here is an outline of paper work involved, which should be of interest to both flight operators and colleges giving ground school instruction. *The Sportsman Pilot*, October 15, 1940, pages 10, 11, 44, 45, 3 illus.

A Veteran Pilot Discusses Light Plane Training. Byron A. Glover. Light plane pilot training is of little value in the training of military pilots, according to this instructor of a school which gives primary training to Flying Cadets of the Air Corps. *The Sportsman Pilot*, October 15, 1940, pages 12, 36, 37.

Night Flight From Malton. Description of a night training flight for Canadian student navigator-observers. *Commercial Aviation*, October 1940, page 46, 1 illus.

Die Anderung der Elements Magnetischer Storgebiete mit der Hohe und ihr Einfluss auf die Flugnavigation. (Variation of the Elements of Areas of Magnetic Interference with Altitude, and the Effect of this Variation on Air Navigation.) Karl Ramsayer. (Report of the D.V.L. Institute for board instrument and navigation.) The author, aboard an airship, investigated declination and horizontal intensity in various altitudes above one of Germany's areas of strongest interference (the anomaly of Bockwitz-Reudnitz, in Saxony) in order to determine whether areas of magnetic interference in Germany may affect air navigation. He also calculated the values according to Malkin's method, to determine the effectiveness of this method, as compared to the measurements. *Luftfahrtforschung*, June 20, 1940, pages 174–188.

Instrument Flying

Blind Landing According to the Z.Z. System. H. Henrikson. Graphic description of the Z.Z. blind landing method. *Flygning*, August 1940, pages 1–3, 7, 7 illus.

Blind Landing. Alexander Klemin. Blind landing system, as developed by the International Telephone Development Company, is being installed at La Guardia Field, New York; Meacham Field, Ft. Worth; Mines Field, Los Angeles; and the Municipal Airports of Chicago, Cleveland and Kansas City. Operating on ultra short waves the runway localizer course is given by overlapping horizontal radio field patterns, with glide path further marked by two vertical beacons. A glide path transmitter at the airport provides a path of constant electric field intensity which the pilot follows in by means of a cross pointer indicator. A horizontal needle shows altitude in relation to glide path and a vertical needle provides lateral guidance. *Scientific American*, November 1940, pages 260, 261, 4 illus.

Instrument Landing System Now Ready for Airline Use. Summary of the experimental background and development of the C.A.A. instrument landing system recently installed in

ten large airports in the United States. Also included is a complete and understandable explanation of how the system works. *Canadian Aviation*, October 1940, pages 26–29, 5 illus.

Overcoming Conditions of Zero-Zero. John D. Woodward. Operation of the runway localizer and landing beam method of instrument landings is given with a description of Bendix transmitter equipment. *Commercial Aviation*, October 1940, pages 33–35, 56, 5 illus.

Law

To Sue or Not to Sue. Solomon Rothfeld. Survey of court cases describing the legal rights of airport operators and their neighbors. *Aviation*, November 1940, pages 42, 43, 134, 4 illus.

Legal Experience of Airports. Charles S. Rhyne. A review of legal experience of privately and publicly owned airports, from acquisition and everyday operation to the problems of protecting airport approaches and at the same time giving consideration to the rights of nearby property owners. Problems of ownership, operation and protection are stated as they have arisen and points relative to their settlement discussed. Liberal use of footnotes gives complete reference data on the many cases involved. *Journal of Air Law and Commerce*, October 1940, pages 297–319.

State Control of Aeronautics. Charles L. Morris. The case for state control of aeronautics in reply to a paper by Mrs. Mable Walker Willebrandt in the July issue of the *Journal of Air Law and Commerce*, advocating complete and exclusive federal control over aeronautics. The author, who is Commissioner of Aeronautics for the State of Connecticut, discusses inadequate protection due to constitutional and budgetary limitations; wide differences in terrain, number of pilots and aircraft, and the difficulty of applying uniform administrative control to sectional problems. *Journal of Air Law and Commerce*, October 1940, pages 320–330.

Lighter-than-Air

Our Lighter-than-Air Policy. Lieutenant Francis X. Carmody, U.S. Navy (Retired). A re-examination of possibilities of rigid and non-rigid dirigibles for coastal patrol and reconnaisance is suggested by the author. It is stated that knowledge of weather and airship handling gained from former experiences would make future losses far less probable. An interesting comparison is made between large dirigibles and aircraft carriers as bases for scouting planes, and it is stated that planes can be launched from dirigibles under weather conditions which would make it impossible either to take off or land on the deck of a carrier. *U.S. Naval Institute Proceedings*, November 1940, pages 1586–1589, 3 illus., pages 1622–1624.

Truck Serves as Mobile Base for Army Observation Balloon. Balloons for the U.S. Army with interchangeable motor gondolas and observation baskets are now accompanied by trucks which serve both as mobile mooring masts and maintenance bases. The balloons are used for spotting artillery fire. *Popular Mechanics*, December 1940, page 844, 1 illus.

Destination Unknown. Picture-caption series showing the complete training flight of a Navy balloon, from inflation and take-off to the landing, deflation and loading on a truck for the trip back to the home base. *Air Trails*, December 1940, pages 10, 11, 15 illus.

Manufacture

Some Simple Methods of Speeding Up Airplane Production. Paul G. Zimmermann, Douglas Aircraft Co. The author states that once a mass production expert sets foot inside an airplane plant, either he acknowledges that the problem is different, or pushes his way forward until vast sums are spent on scrapped materials. He then goes on to give examples of important differences and gives some solutions of production problems as practiced at Douglas, which include (1) accurate bills of material, (2) scheduled engineering, procurement and production, (3) erection lists prepared by the engineering department with the help of shop, (4) tote pan material distribution, (5) fixed station assembly, and (6) a bonus for intelligent supervision. Abstract from S.A.E. Preprint for National Aircraft Production Meeting. *Aero Digest*, November 1940, pages 138, 141.

The Problem of Aircraft Parts. R. J. Wenger. The Bendix plant on the Pacific Coast, of which he is superintendent, makes shock absorber struts for landing gears, and a complete line of hydraulic equipment. Formerly it produced parts in lots of 12 to 100, now units in lots of 1000 to 1200. Production planning and control are analyzed briefly. One machine of each type is unscheduled and used for "catch-up" jobs, being shifted from one task to another as delivery needs require. Final inspectors work within the final assembly department. Plant works three shifts, but the maintenance crew is employed on the day shift only, since most of the equipment is quite new. *American Machinist*, October 1940, pages 876–878, 3 illus.

Welding of Aluminum. G. O. Hoglund. A survey of modern aluminum welding. It is stated electric resistance welding is in wider use in fabricating aluminum alloy parts, because of economy, adaptability to large-scale production, and preservation of the smooth surfaces of parts exposed to the air stream. Several thousand airplane tanks have been spot welded during the past four or five years, with no service difficulties. During the past year there has been an extension of both brazing and fusion welding in production work on aluminum parts. *Metal Progress*, October 1940, page 483.

Producing Aircraft Stampings in the Douglas Plant. Herbert Chase. A comprehensive description of the stamping of parts from aluminum and magnesium alloy sheets. Special zinc or soft alloy dies are largely used. There is also a presentation of the Guerin process as developed by Henry E. Guerin, factory manager of the Douglas plant at Santa Monica. In this process, rubber is used for the positive punch, achieving numerous advantages as well as effective results. *Metals and Alloys*, October 1940, pages 436–441, 9 illus.

How to Bend Tubes and Sections. Description of methods of using Cerrobend as a filler for tubes and sections that are to be bent. This alloy of bismuth, lead, tin and cadmium melts at 160°F. and when cooled by chilling is ductile. It is used in aircraft factories in bending fuel, oil and hydraulic pipe lines, and also tubular structural members. It can also be employed in bending rolled sections, such sections being embedded in the alloy. *Iron Age*, November 1940, pages 52, 53, 3 illus.

Bending Press Dies for Airplane Manufacture. Cyril J. Bath. Dies for bending presses may be of rubber, wood, plaster of paris, cast zinc, and similar materials. Only when high unit pressures are required, or when a large number of pieces must be produced from a single die, is it necessary to use more durable and more expensive steel. Dies used for forming, bending, drawing and punching long metal sections for aircraft sometimes may have inserts, or be adjustable, permitting pressing several different sections with the one die. *Machinery*, November 1940, pages 152–155, 9 illus.

Refrigeration in Aircraft Engineering. Prestcold refrigerators, used in delaying the age hardening of aluminum for aircraft construction, are described. *The Aeroplane*, September 13, 1940, page 300, 1 illus.

The Jigging of Modern Airframes. Introduction to a series of articles

about assembly methods in modern warplane construction employed by the major airplane producing countries of the world. Problems of jigging and methods of breaking down over-all assembly to more easily handled sub-assembly units will be discussed and examples given of sub-assembly breakdowns used in the construction of current types of warplanes. *Aircraft Engineering*, October 1940, pages 311–313, 14 illus.

Building for Defense. Five pages of production pictures and captions, showing the building of airplanes, engines, guns and torpedoes. *Popular Mechanics*, December 1940, pages 828–832, 18 illus.

The World's Biggest Bomber. Two pages of construction pictures of the Douglas B-19, 80-ton bomber for the Army. *Popular Mechanics*, December 1940, pages 814–815, 7 illus.

Multiple Duplication of Assembly Fixtures by the Taber-Van Dusen Method. Phillip Taber and L. W. Van Dusen. Time lag between full scale loft layout and the completion of production fixtures has been practically eliminated by contact photoprinting details of master pattern boards directly onto any number of identical fixture boards. Time saved on duplicating certain assembly fixtures came to nearly 90 percent, or from 3000 manhours to 400 manhours. *Aviation*, November 1940, pages 53, 120, 1 illus.

The Use of Rubber in Press Work. An important development in the quantity production of aircraft is the increased use made of rubber in hydraulic presses which stamp out parts from aircraft alloys. As rubber under pressure reacts as a liquid and exerts even pressure, and because of its low compressibility and ready adaptability to any shape, rubber makes an ideal female die. Raising, drawing, blanking and forming operations are explained and illustrated. *Aircraft Production*, October 1940, pages 323–325, 13 illus.

A Light Alloy Foundry. High performance chill cast rods from improved production methods of John Dale Metal Containers Ltd., are compared with high tensile extruded bar for heavy loads and stress. *Aircraft Production*, October 1940, page 336, 5 illus.

Speeding Lightplane Production. W. E. Hirtensteiner. Notes on production short cuts in building the Interstate Cadet lightplane trainer. *Aviation*, November 1940, pages 64–65, 120, 5 illus.

The Airspeed Oxford. Part I. Wilfred E. Goff. An account of the construction of a popular British twin-engined training airplane. Part I begins with the delivery of spruce boom laminations to the spar shop, their fabrication and assembly, on to assembly of center sections and concludes with control surface sections and covering. *Aircraft Production*, October 1940, pages 313–320, 24 illus.

Getting the Most Out of Machines. C. W. S. Parsons. Machine loading charts are now being used by many West Coast sub-contractors and machine shops to give a clearer picture of what kind and how much machine hour capacity is available to aircraft manufacturers during any given period. By so doing they hope to untangle some of the order and priority jams caused by the rush of orders and pressure of follow-up men. A typical machine loading chart is shown for use with engine lathes. *Aviation*, November 1940, pages 54, 55, 130, 3 illus.

Cutting Production Costs by Die Casting. Herbert Chase. Discussion of modern die casting for the aircraft industry. Casting processes have been improved to include magnesium alloys and this together with the present day necessity for large scale production of parts makes it practicable for manufacturers to use die casting more extensively. *Aviation*, November 1940, pages 56, 57, 128, 8 illus.

Warplane Factories in Germany. Part II. Paul H. Wilkinson. Visit to the largest airplane factories in the world, the Junkers plants at Dessau. Most warplane plants in Germany specialize in a single sub-assembly unit, airframes, engines, wings, propellers and so on. Junkers not only builds them all in large quantities, but does so with amazing speed and efficiency. *Aviation*, November 1940, pages 44, 45, 122, 5 illus.

Bombers in Quantity. Jay P. Au-Werter. Production story of three or more bombers a day at The Glenn L. Martin plant. Careful planning of parts to be sub-contracted, scheduling of operations and breakdown into easy to handle sub-assembly units, efficient tool design, all are vital phases of this splendid job of production engineering. Departments contributing to production speed are described with several speed-up processes developed by The Glenn L. Martin Company. *Aviation*, November 1940, pages 34–37, 108, 11 illus.

Making the Canadian Harvard Trainer. R. C. Tiplady. Plant organization, layout and operation methods of Noorduyn Aviation Ltd., Montreal makers of the Canadian Harvard Trainer are patterned closely after those of North American Aviation Inc. After a brief description of the Montreal plant, fabrication and assembly of the all-metal two-place Canadian Harvard Trainer is outlined, from preliminary cutting of tube stock to the final engine installation and check. *Canadian Aviation*, October 1940, pages 19–22, 46, 11 illus.

Mass Production. Elizabeth M. G. MacGill. An analysis of the mass production possibilities of airplanes as compared with production methods achieved in the motor car industry. While the demands of war far exceed the supply of warplanes, there has been little assembly line production of planes as encountered in automobile assembly plants. Factors governing mass production, such as problems of changes in design, wide range of desired performance, availability of mass markets, as well as questions of plant size and the feasibility of tooling on a scale comparable to that of the automobile industry are outlined in detail. *Flight*, September 19, 1940, pages 228–231.

Noorduyn Swings Into Harvard Production. Percy T. Cole. The choice by Noorduyn Aviation Ltd. of the North American Harvard trainer was based not only upon its performance and adaptability to Canadian training conditions, but also upon the readiness with which it lends itself to mass production. In the short space of ten months the Noorduyn Plant at Montreal has been equipped and tooled for assembly line production of its first order for 100 Harvard trainers. Details of how the task was accomplished and plans for high speed production are given. *Commercial Aviation*, October 1940, pages 25–29, 15 illus.

Uncle Sam Builds a Europe-And-Back Warplane. Andrew R. Boone. Further descriptive material on the giant Douglas B-19 bomber nearing completion in California. Weight fully loaded has been given as between 70 and 80 tons; top speed from four 2000 hp. Wright Cyclones, 210 m.p.h.; bomb load 18 tons; fuel load 11,000 gallons; wing spread 212 feet; over-all length 135 feet; cruising range 7750 miles. Story of its design and construction is shown with pictures and captions. *Popular Science*, December 1940, pages 56–59, 7 illus.

The Use of Rubber for Producing Sheet Metal Parts. Chris J. Frey and Stanley S. Kogut. A review of the aircraft industry's ever-growing use of hydraulic presses with rubber pads substituted for steel die work and hand labor of the past. The use of rubber in a press was patented back in 1872 by Delkescamp, but shearing and blanking in rubber as used today in the aircraft industry was developed by Henry A. Guerin. Present day

methods and different types of operation are shown. *Aero Digest*, November 1940, pages 129, 130, 133, 134, 11 illus.

Moulding and Casting Aluminum Alloy Cylinder Heads. At the Wright Aeronautical Corporation's Fairlawn, N. J., plant the first line-production foundry devoted solely to moulding and casting aluminum alloy cylinder heads is now in production. Production sequence is outlined and illustrated. *Aero Digest*, November 1940, pages 114, 115, 12 illus.

Expansion Plans for Airplane and Engine Factories. A company-by-company survey of expansion plans for the following: North American, Grumman, Bell, Taylorcraft, Curtiss-Wright, Boeing-Stearman, Northrop, and Pratt & Whitney. *Aero Digest*, November 1940, pages 37–41, 7 illus.

Aircraft Electrical Equipment. F. G. Spreadbury. Production problems caused by special requirements in electrical equipment for airplanes are outlined and suggestions offered for their solution. *Aircraft Production*, October 1940, pages 331–333, 9 illus.

Materials Testing

Modern Aircraft Materials and Their Testing. Kenneth R. Jackman. Story of the never ending search for lighter weight, less expensive, and readily fabricated aircraft materials. The author, Chief Structural Test Engineer for Consolidated Aircraft Corporation, discusses modern aircraft materials including beryllium which is lighter than aluminum, hard as sapphire and more elastic than steel. Different alloys of both aluminum and steel and bonded plywood plastic materials are discussed. New fabrication methods which increases strength and performance of older materials are outlined together with newer developments in strain-measurement techniques used in testing materials. *S.A.E. Journal*, November 1940, 461–473, 496, 17 illus.

Metalleruas Korrosionsutmattning. (Corrosion Phenomena on Metals.) Dr.-Eng. F. Neumeyer. Study on the effect of corrosion on metals. Researches of various scientists; testing equipment, and graphs of the test results. *Flygning*, August 1940, pages I–V.

Zur Danerfestigkeit von Duralblech-Nietungen. (On Fatigue Strength of Rivetings on Dural Sheets.) E. Hottenrott. (Report of the Dornier Works, G.M.B.T.) In metal airplane construction, the separate skin parts are usually connected to one another and to the supporting framework by means of rivets. Calculation is based on the known strength factors of the materials for rivet shear, hole bulging and stress on the metal sheet. The author describes a test to determine the fatigue strength of a dural rivet connection on which various types of rivets were used. *Luftfahrtforschung*, August 20, 1940, pages 247–250.

Materials

Plating of Aircraft Parts. George E. Stoll. Brief note on the plating of landing gear parts to prevent corrosion and reduce wear. Chromium is used, and also bright zinc plating. The latter is improved in corrosion resistance if given a chromate dip, increasing salt spray resistance by more than 50 percent. *Metal Progress*, October 1940, page 431.

Rating of Aircraft Quality Steels—Magnaflux Inspection. J. B. Johnson. The author states that it is impossible to give a simple definition of the term "aircraft quality." S.A.E. specifications establish certain chemical, grain and physical requirements, and in addition require the finished parts to be subjected to magnetic inspection. There is a similar inspection requirement in Air Corps and A-N specifications. It is stated that only magnaflux inspection has proved practicable. It indicates non-homogeneity at or just below the surface, such as cracks, laps, seams and nonmetallic inclusions. Since such inclusions may be tolerated to a greater extent in low-stressed than in high-stressed parts and sections, it is pointed out that there is a need to define "aircraft quality" on the basis of the requirements of each particular design. *Metal Progress*, October 1940, pages 382–383.

Magnesium in Aircraft. Norman E. Woldman. Though aluminum is the principal metal used in aircraft manufacture, magnesium and its alloys are being given increased attention. The author presents the comparative properties of various metals and alloys, and discusses the advantages and disadvantages of magnesium alloys, with suggestions for overcoming difficulties such as corrosion. There is a list of the present uses of magnesium alloys in aircraft. *Metals and Alloys*, October 1940, pages 430–435, 16 illus.

Stainless Steel Hangars at Municipal Airport. At the New York Municipal Airport (LaGuardia Field), 18–8 stainless steel was used in gages from 12 to 24 as embellishment. Many walls, which are of brick over structural steel, were faced with this material. Unusually large panels had to be produced, and slots had to be provided for the bolts in order to permit expansion and contraction with temperature changes. Details are given, including plans, explaining the method of application to walls and cornices. *Sheet Metal Worker*, October 1940, pages 32–34, 7 illus.

Fatigue in Aeroplane Structures. O. Nissen. An analysis of structural failure in airplanes due to fatigue by a German engineer. Many examples of structural failure due to fatigue and its number one cause—vibration, are illustrated. Time-strength factors of materials are also discussed together with problems of parts manufacture and their bearing on structural failure traceable to vibration and fatigue. *Aircraft Engineering*, October 1940, pages 293–295, 306, 16 illus.

Medicine

Fundamental Facts About Aviation Medicine. E. V. Nystrum. The author starts his study with the first balloon flight of Pilatre de Rozier. He brings it up-to-date by going into details on researches made on the effect of flying on the physiology and psychology of man. *Flygning*, August 1940, pages 10, 11, 5 illus.

The Man of 1 Meter—64. A. Zimmerman. A Fokker made a crash landing at dusk at the Croyden Airport. Although the machine was a total wreck, no lives were lost. An investigation by the C.I.N.A. revealed that the very experienced pilot was twilight-blind. This started a new line of physical examination. The author describes this test in detail and also the general fitness test. *Luchtvaart*, August 20, 1940, pages 308–314.

Magic Masks. Joseph A. Ferris. Pure oxygen masks as developed for high altitude flight by the Mayo Foundation are being used as emergency oxygen equipment in the treatment of London's bombing casualties. Adaptable either to a self contained unit or central supply system as would be used for passengers of an airliner, the new equipment provides metered oxygen to match altitude requirements. Also included is the story of its development and details of an experimental altitude pressure tank. *Airlanes*, October 1940, pages 4, 5, 19, 6 illus.

Physiology of Aviation and Medical Preparedness. J. F. Fulton, M.D. The author presents general principles and some of the special problems of aviation medicine. Among the latter, air sickness, anoxia, the effects of altitude upon the balance of pressure of elements in the bloodstream, and physiological effects of power dive pull-outs are discussed. *Connecticut State Medical Journal*, October 1940.

Meteorology

An Improved Radio Sonde and Its Performance. Harry Diamond, Wilbur S. Hinman, Jr., Francis W. Dunmore and Evan G. Lapham. An improved radio sonde, described in Research Paper RP1082 (1938) has been put into daily service by many stations of the Government aerological services. This paper (RP1329) gives details of construction and operation, record of a typical sounding, and performance data on accuracy of measurements, especially of a new element which measures relative humidity. The authors state that modification of the unit is possible for design of an instrument specially adapted to stratosphere investigation. *Journal of Research of the National Bureau of Standards*, September 1940, pages 327–367, 34 illus., 4 tables.

Military Aviation

In Defence of America. Text comments on American resentment at British labeling of certain American planes as obsolete. The article emphasizes the need for the best the United States can produce. *The Aeroplane*, September 13, 1940, pages 284–286, 10 illus.

Flying Trains. Experiments in the military possibilities of troop carrying glider trains which would divide and scatter to different objectives. *Aeronautics*, October 1940, page 28.

Facts and Figures. Figures and charts on the growth of aviation in Canada and Australia. Also a chart showing the world sources of petroleum. *Aeronautics*, October 1940, page 29.

Unveiling the Luftwaffe. Numbers of German warplanes shot down and repaired by the British are touring R.A.F. stations so that fighter pilots can fly them and learn the weak points in their flying characteristics for later combat work against them. It is said that the large numbers of enemy airplanes now available for study by the R.A.F. are worth more than information it would take the Intelligence Service years to gather. *The Aeroplane*, October 11, 1940, page 393, 5 illus.

Wright Field Booms. Douglas J. Ingells. Details of building and the expansion of test facilities at Wright Field. New engineering and test laboratories, armament test range, and a new wind tunnel with a 20 foot test section, are described. *Flying & Popular Aviation*, November 1940, pages 40–42, 5 illus.

Robot Television Bomber. A flying bomb with a television eye to seek out its target is proposed by Dr. Lee De Forest and U. A. Sanabria. *Popular Mechanics*, December 1940, pages 805, 806, 6 illus.

Italian Fighters Found Wanting. Gordon A. Reves. Italy's relative strength as measured by her fighter performance. Construction notes and performance specifications given on the Fiat CR-42, CR-32, G-50, Macchi C-200, Caproni 165, Meridi RO-41, RO-51, Caproni Reggiane 2000, Caproni Vizzola F-5, and the A.U.T. 18. *Canadian Aviation*, October 1940, pages 23–25, 40, 6 illus.

A Coastal Command Station. Major F. A. de V. Robertson, V.D. Official duties of the R.A.F. Coastal Command are coastal patrol, observation and reconaissance. However this visitor reports that fighting is their chief sport, with no odds barred. According to the writer this station has downed nearly every type of warplane in use by the Nazis and one or two submarines besides. Lockheed Hudsons have made their reputation with the Coastal Command due to their roomy comfort and ability to absorb punishment. Notes about personnel, operations and some interesting action stories are also given. *Flight*, October 17, 1940, pages 324a–326, 15 illus.

The Eagle Takes the Air. Story of the American Fighter Squadron organized recently in England by Colonel Charles Sweeny. Successor to the Lafayette Escadrille the new squadron is in training under Squadron Leader W. E. G. Taylor, a former U.S. Navy flier who has been serving in the R.A.F. for the past year. Recruiting office for the new unit is in Montreal, at the Mount Royal Hotel, and inquiries can be forwarded to that address. Non-flying personnel may also apply. *Flight*, October 17, 1940, page 331, 3 illus.

Signal Lamps Direct War Pilots in Patrol Formations. Showing a special flasher type of signal lamp with telescopic sight which can be aimed at the receiver. Its purpose is to avoid the use of radio when there is danger of revealing position. *Popular Science*, December 1940, page 67, 1 illus.

You Try Dive Bombing. John R. Hoyt. Because of the speed and complexity of the necessary routine to be followed, dive bombing requires all the skill, timing and judgment a pilot possesses. Here is a vivid account of the dive bombing maneuver. *Air Trails*, October 1940, pages 14, 15, 48, 62, 63, 4 illus.

Der Bombonwurt aus dem Sturgflug und dem Steigflug. (Bomb Dropping During Diving and Climbing.) H. Athen. Based on the elements of bomb dropping from horizontal flight, the elements of bomb dropping during any flight attitude (diving or climbing) are determined. The decrease of the weight of standard air with altitude is taken into consideration. The method uses a principle which is known in ballistics as "the swinging of the flight path according to the fishing rod principle." Errors, due to swinging, are compensated by the application of Popoff's parameter developments for external ballistics. It is not only possible to determine the paths at any flight altitude from the end elements of the paths at horizontal flight, but also to deduce functions which make it possible to specify intermediate points of any path of the bomb type under consideration. *Luftfahrtforschung*, July 20, 1940, pages 216–220.

Air Strategy—XXII, Air Blockade—XII. Eastern Germany is a Great Strategic Target. Captain Norman Macmillan. Outline of a plan for the creating of an independent offensive division of the R.A.F. solely for the purpose of carrying total and unremitting air war against industrial production centers of the enemy. To date, lack of warplane strength has forced the R.A.F. to concentrate its attacks against military objectives, especially the channel ports, to offset invasion attempts. This diversion of bomber strength has hampered offensive action to cripple Germany's production centers and the highly important operation of air blockade which are such vital phases of total air warfare. It is stated that the chief need of the R.A.F. at present is large numbers of ultra long range bombers which can be used against any and every production center in both Germany and Italy. *Flight*, October 3, 1940, pages 272–274, 1 illus.

New Falcons For the War. Leonard Engel. England's 1941 model warplanes are nearly ready to take the air. Names and details of fighters and bombers shortly to be put into service. Included are the Hawker Tornado, Westland Whirlwind, Avro Manchester, Short Sterling, re-engined and more powerful models of the Vickers Wellington, Handley Page Hampden and Whitworth Whiteley, which have been the backbone of the R.A.F. Bomber Command. *Flying & Popular Aviation*, November 1940, pages 12, 14, 68, 5 illus.

Target Airplane on Trolley Trains British Air Gunners. A model airplane suspended from a wire on a trolley roller "flies" past the gunner who practises shooting at it with a camera gun equipped with service sights. *Popular Mechanics*, December 1940, page 827, 1 illus.

Frontiers. Robert C. Morrision. Development news from the wide-flung research fronts of the industry. Armor for interceptors, bullet-proof glass, bullet-proof tanks, armor protection for bombers are discussed together with notes on new fighters, bombers, trainers and engines now under test. *Model Airplane News*, November 1940, pages 21, 62–66, 7 illus.

Air Strategy XXIV—Air Blockade XIV. Captain Norman Macmillan. Air policy from the tactical probability that any attack on England would be made simultaneously from the channel ports and Ireland. The writer also stresses the importance of continuous attack by long range bombers over southeastern Germany before safety zones of industrial production can be established out of range of present bombing operations. It is proposed to force Germany to build more fighters and fewer bombers and lessen the bombing attacks over England by carrying the air war to Germany through the use of long range fighters and bombers. *Flight*, October 10, 1940, pages 327–329.

Fire Control and Manoeuvre in Mass Formations. An anonymous British writer proposes mass fleet aircraft formations and outlines control techniques, flying formations, and changes in aircraft design and fire power which the changeover from present day individual combat to fleet operations would entail. Of special interest is the author's drawing of a proposed commanding officer's flagship or control plane, a four motored high altitude general headquarters of the air. *Aeronautics*, October 1940, pages 24–27, 5 illus.

Elementary Mechanics of Bombing. Fundamentals of bomb trajectories, terminal velocity, and range of warning sound. A chart with a series of bomb trajectories is included, based on the assumption of no air resistance. The difference between these theoretical trajectories and actual trajectories caused by air resistance is also analyzed. Reflects the British people's intense interest in practical methods for gaging potential danger from bombs which can be heard, as well as bombers visible overhead. *Flight*, October 3, 1940, pages 269–270, 1 illus.

Miscellaneous Equipment

Air Mail Pick-Up. Description of new type equipment to be used by the All American Aviation Company on its five air pick-up routes for air mail and air express. The airplane hooking gear is now mounted at the end of a pole hinged to the tail of the airplane. Ground gear can be simplified to a pair of twenty foot bamboo poles which hold open the loop of rope to which the mail or express pouch is attached. *Aviation*, November 1940, pages 46, 126, 3 illus.

Aircraft Electricity as the Airlines Operator Sees It. P. C. Sandretto, United Airlines Transport Corp. The growth of electrical equipment in aviation is outlined. The author states that in a commercial transport auxiliary power is required for operation, avigation and service. An analysis of power required for a DC-3 shows that 73 percent is used for avigation, 19.8 percent for service of passenger equipment, and 7.2 percent for operations or flight. Probable future electrical equipment and installations in larger transports also are described. Abstract from S.A.E. Preprint for National Aircraft Production Meeting. *Aero Digest*, November 1940, pages 137–138.

Self-Sealing Oil Tanks. The Henderson Safety Tank Co.'s new tank described. *The Aeroplane*, September 13, 1940, page 300, 2 illus.

Den Elektriska Utrustningen i Flygplan och pa Flygmotorer. (Electrical Equipment for Airplanes and Aircraft Engines). Birger Liugert. Installations for power, light and instruments on airplanes and aircraft engines. The author discusses current, voltages, insulations and electrical accessories. *Flygning*, August 1940, pages VI–VIII, 3 illus.

Model Airplanes

Goods' Championship Radio Model. (Part Two.) Walter and Bill Good. Part Two gives the construction details and drawings of the radio receiver and control units of their radio controlled model. Plans and instructions for installing the miniature equipment in the plane are also given. *Air Trails*, December 1940, pages 30–34, 49–52, 21 illus.

Lanzo Nationals Stick Winner. Chester Lanzo. Construction plans and details of an unusually large rubber powered model airplane. Features a wing area of 300 sq. in. instead of the usual 200, propeller blades which fold back against the fuselage, and timer rudder control which will enable it to stick in almost any thermal. Best flight is 63 minutes. *Air Trails*, December 1940, pages 38–40, 58, 5 illus.

The Nationals Point to Future Design. Henry Struck. Trends in model airplane design as shown at the recent national meet held in Chicago. *Air Trails*, October 1940, pages 30–35, 48, 56 illus.

Buzzard Bombshell. Joe Konefes. Plans by Paul Plecan. Success story and plans of the Class C Open record breaking model as developed by the Chicago "Buzzards," a unique model group who fly models every Sunday, rain or shine. *Air Trails*, October 1940, pages 36–37, 46, plans on pages 38–40, 4 illus.

A Flying Messerschmitt Pursuit. Earl Stahl. Construction plans and directions for building a flying model of the famous Me-109. *Model Airplane News*, November 1940, pages 24, 66–68, 6 illus., 4 pages of drawings.

Fundamentals of Model Plane Control. Charles Hampson Grant. Suggestions on design modifications which make it possible to obtain better directional control for contest models. This can often be done by varying the angle made by the line of thrust and a line drawn through the center of lateral area and the center of gravity known as the neutral axis. Methods of varying this angle by changing location of fin area above or below the fuselage are shown. *Model Airplane News*, November 1940, pages 19, 46, 47, 4 illus.

Wedgy the Record Smasher. Leon Schulman. Construction plans and data of an odd looking Class A Nationals winner which has placed among the first three in every contest entered. *Model Airplane News*, November 1940, pages 16–18, 44, 46, 3 illus.

The World's Biggest Bomber. Robert McLarren. Model builder's details of the giant Douglas B-19 four-motored bomber, the largest airplane ever built. *Model Airplane News*, November 1940, pages 14, 15, 60–62, 1 illus., 1 page drawings for scale model.

Naval Aviation

Aircraft of the Fleet Air Arm. General survey of various types of airplanes now in use by the R.A.F. Fleet Air Arm. These include the Fairey Swordfish, the Blackburn Shark, Skua, and Roc, the Fairey Fulmar and Albacore, De Havilland Queen Bee and Airspeed Queen Wasp. *Flight*, October 10, 1940, pages 297–301, 10 illus.

The Patrol Plane and the Future. Lieutenant Commander A. B. Vosseller, U.S.N. An analysis and comparison of large flying boats to large land based airplanes for purposes of long range patrol and bombing operations. It is shown that range and load capacities tend to increase more rapidly with increased size in flying boats than with large land planes. It is also pointed out that size of airports limit the size and wing loading of land based aircraft. The author believes not only that flying boats in the hundred ton class would be far more efficient for over-water military purposes but also for over-land passenger and transport, and supports

his contention with a map showing hundreds of inland locations suitable for take-offs and landings by large flying boats. *United States Naval Institute Proceedings*, November 1940, pages 1569–1585, 8 illus.

The Fleet Air Arm. Major F. A. de V. Robertson, V.D. The story of how the Fleet Air Arm, Britain's Naval Air Force, was born in the bamboo and varnish days of flying. It begins with Francis McClean, a patriotic aviation enthusiast, who volunteered in 1911 to teach four Naval Officers to fly at his own aerodrome at the Isle of Sheppy. Much to the surprise of the admirals, over 200 young officers volunteered. On April 13, 1912, by Royal Warrant signed by George V, the Royal Flying Corps for both the Army and the Navy came into being. Soon the title of Royal Flying Corps (Naval Wing) aviation was dropped, and the Admiralty began to write officially of the Royal Naval Air Service.

The narrative tells of the first use of deck landings on the H.M.S. Africa, the use of a seaplane at the Battle of Jutland, as well as the first seaplane tender the world ever knew, H.M.S. Ark Royal, a converted tramp steamer.

The Royal Navy's not too successful operation of lighter-than-air, with much inside information on where the original data was secured, is also interesting. After the first World War, both air forces were merged into a central body, The Royal Air Force.

This service took over the development of the aircraft carriers, which were first used late in 1918. Catapult seaplanes and folding wing amphibians were developed for cruisers and auxiliary ships.

Yielding to the pressure of the Lords of the Admiralty, the Air Ministry in 1923 reassigned pilots and observers directly to the fleet. This led to a slow return of Air Power to the Navy, until, in 1937, the Air Ministry returned full command of Naval Aviation to the Fleet Air Arm. *Flight*, October 10, 1940, pages 290–296, 26 illus.

Navigation

Uniformity in Air Navigation. A survey of terminology and suggestions for attaining international uniformity in terms and abbreviations. *Aeronautics*, October 1940, pages 76, 79, 80.

Land Charts for Air Navigation. Francis Chichester. The case for the mercator projection method in preparation of air charts. *Aeronautics*, October 1940, pages 46–48, 3 illus.

Navigation in a Nutshell. Details of construction and operation of a roller map case using roller strip maps. *The Aeroplane*, September 20, 1940, pages 328, 329, 5 illus.

Niagara's of Wind. Alma Heflin. Lightplane pilots flying over mountains must be on the alert for sudden vertical air currents and tricky crosswinds. *Air Trails*, October 1940, pages 25, 56, 57, 4 illus.

Airline Navigation Was Different in Europe. Lewis M. Gravis. An American airline pilot formerly with K.L.M. (Royal Dutch Airlines) describes the methods of radio navigation used by the world's oldest airline. He compares equipment, personnel and systems, and points out lessons that can be learned from the K.L.M. method on its Batavia run. *Aviation*, November 1940, pages 40, 41, 118, 3 illus.

Celestial Navigation in Wartime. Commander P. V. H. Weems. Analysis of the problems of high altitude night flying over enemy territory indicates that celestial navigation is the safest method, according to the author. Equipment, latest methods of obtaining a fix with speed and accuracy, and an example of a problem already worked are explained. *Commercial Aviation*, October 1940, pages 41–44, 4 illus.

Navigation for Defense. T. C. Gilmer. Celestial navigation simplified for speed now plays vital role in long distance military flying. *Flying & Popular Aviation*, November 1940, pages 43, 44, 5 illus.

Earth's Rotational Effect on the Bubble Sextant. Lieutenant Commander P. V. H. Weems, U.S.N. (Retired) and Captain T. L. Thurlow, U.S. Army Air Corps. (Reprinted from U.S. Naval Institute Proceedings.) In addition to well known transient acceleration errors of the bubble sextant in flight, it has been noticed that error on the beam is greater than error on the head, which has been found to result from the fact that the earth's rotation combined with the speed of the airplane causes a pendulum or a bubble to indicate a false zenith or horizon. The method of predicting and correcting this error is given, with the necessary formulae and tables. *Aero Digest*, November 1940, pages 56, 57, 6 illus.

Parachutes

Parachute Troops. Although Sebastian Lenormande is considered the first man to descend by parachute in 1783, the first military parachutist was Captain Leslie Balfour who jumped from an airplane near Arras during the World War. The article gives an outline of the military application of the parachute. *Luchtvaart*, September 3, 1940, pages 322–323.

The Life Preservers. Outline of the activities of the Irving Air Chute of Great Britain, Ltd., with notice of the new Irvin Harnesuit. *The Aeroplane*, September 13, 1940, pages 298, 299, 9 illus.

Personalities

One Girl's Aviation. Georgette Meyer. The author's experiences as an aviation news reporter include a flood relief flight with Captain William Wincapow, terminal velocity dives and combat maneuvers with test pilot S. A. Converse of Grumman Aircraft. *Air Trails*, October 1940, pages 24, 59, 60, 3 illus.

He Hated Flying. Hill Edwards. Actor Brian Aherne hated flying until Ruth Chatterton talked him into a ride. Since then he has logged 400 hours. *Flying & Popular Aviation*, November 1940, pages 39, 56, 80, 2 illus.

I Learned About Flying From That. Tex Rankin. If you wish to avoid washing out a new plane on the side of a mountain, take nothing for granted. Here are some of the reasons why even new planes must be checked carefully. *Flying and Popular Aviation*, November 1940, pages 29, 54, 66, 1 illus.

The Gospel Goes By Air. Edward Lawson. Pastorate of the Rev. George E. Fisk extends far into the wilds of Borneo. Having learned to fly at Floyd Bennett Field, he now carries religious education and modern medical service to his Dyak converts in a five place Beechcraft, equipped with Edo Floats and fitted out as a modern ambulance. *Flying and Popular Aviation*, November 1940, pages 22, 23, 75, 4 illus.

Plane Packer. Howard J. Emerson. George C. Dade, who began as a promising pilot at 16, now designs special packing cases and supervises the shipping of warplanes to Europe. Story of his adventures as a pilot and how borrowing a family truck from time to time to haul airplanes, finally developed into a large airplane packing and shipping business. *Flying and Popular Aviation*, November 1940, pages 24–26, 58, 60, 9 illus.

Duncan Reviews Canada's Air Effort. James S. Duncan. Canada's Deputy Minister of National Defense for Air states that results to date are far ahead of expectations, and promises greater gains for the future. *Commercial Aviation*, October 1940, pages 48, 50.

Sergeant Hannah, V.C. Commanding Officer's tribute and account of the act by which Sergeant John Hannah earned the V.C. Young Hannah fought and extinguished a fire which practically gutted the fuselage of the Handley Page Hamp-

den bomber of which he was a crew member. The fire, caused by a direct hit from an anti-aircraft shell in the bomb bay, had forced the rear gunner to take to his parachute. Instead of following suit, Hannah donned his oxygen mask and went to work on a fire which melted away part of the aluminum floor before it was brought under control. *Flight*, October 17, 1940, page 332, 2 illus.

Photography

Relief Maps from Aerial Photographs. Details and drawings of a method employed by U.S. Army engineers for producing relief or topographic maps from stereo photographs made by the Air Corps. *Scientific American*, November 1940, page 248, 1 illus.

Private Flying

The Care and Treatment of a Lightplane. Harvey N. Martin. The hows and whys of important safety rules in lightplane maintenance and repair. *Flying & Popular Aviation*, November 1940, pages 32–33, 52, 73, 3 illus.

Madera Round-Up. Johnny E. Smith. Rendezvous of the newly formed West Texas-New Mexico Pilots Association at the ranch of Malcolm Madera, one of the oldest in southeastern New Mexico. *Western Flying*, October 1940, page 9, 5 illus.

Flying Cowboys. Airplanes are widely used for locating stray herds of cattle, especially after storms that drive them away from their own ranges. Modern methods of herding cattle are described. *Popular Mechanics*, December 1940, pages 851–853, 124A, 126A, 9 illus.

Flight to Hatteras. Graham Cameron. Notes from the log of a camping trip flight from Gordonsville, Virginia to Cape Hatteras, North Carolina. *The Sportsman Pilot*, October 15, 1940, pages 19, 32, 33, 34, 3 illus.

Propellers

Investigations on V.P. Airscrews. F. Salzmann and A. von der Muhll. An account of the design and development work on a three blade variable pitch propeller and its hub, together with discussion of the formulae and test problems involved. *Aircraft Engineering*, October 1940, pages 296, 297, 306, 10 illus.

Propeller Vibrations Filmed in Test Flights at Wright Field. In addition to many types of ground test, engine-propeller combinations must undergo flight tests for vibration throughout their range of performance. In single place pursuits, an engineer observer cannot accompany the test pilot, so that automatic recording equipment must be used. Description of the test equipment, its operation, and how it records vibration on film, is given together with an example of how proper interpretation of results can locate trouble in the engine as well as the propeller under test. *Air Corps News Letter*, October 15, 1940, pages 1, 2.

Radio

Radio in Wartime. Radio plays an ever increasing role in the war efforts of the Royal Air Force. *Aeronautics*, October 1940, pages 50, 51, 4 illus.

Radio for Aircraft. Jan Henrik Kylberg. Viewpoints relative to construction and selection of radio equipment for airplanes. The author emphasizes that radio equipment for military or transport planes has to be selected in such a way that clear reception is assured and interference eliminated as much as possible. *Flygning*, August 1940, pages 4–8, 8 illus.

Finch Facsimile Demonstrated. Don Fink. Account of a recent demonstration of aerial radio facsimile transmission by the Finch Telecommunications Company at the Bendix, New Jersey, airport, together with a brief description of the facsimile unit and its operation. *Aviation*, November 1940, pages 48, 132, 3 illus.

Automatic Radio Control. William Stark. Radio control equipment linked directly to the automatic pilot was demonstrated recently by engineers of the Harvey Machine Company of Los Angeles. The new automatic directional control not only follows the beam but actually compensates for drift and maintains course by the action of a second radio beam tuned into the automatic pilot. The effect is that of a cross bearing check control along every foot of the line of flight. *Western Flying*, October 1940, pages 22–24, 3 illus.

Air Youth Radio Game. Part I. Arthur J. Vhay. A plan for practising sending and receiving Morse code, which includes the construction of a simple homemade sending key and buzzer. *Air Youth Horizons*, October 1940, pages 6, 7, 3 illus.

Two New Lear Releases. Don Fink. Details of a new automatic direction finder and its accessory indicator combined with a gyro compass, as announced by Lear Avia. *Aviation*, November 1940, page 50, 3 illus.

Radio and Aviation. Dr. Alfred N. Goldsmith. A discussion of present and future aircraft radio equipment. Dr. Goldsmith traces the development of aircraft radio telegraphy, telephony, facsimile and television. Radio altimetry is explained and its possibilities outlined together with what he terms the ultimate—televisibility, which as yet has not been realized. *Commercial Aviation*, October 1940, pages 52–54, 58, 7 illus.

New Trends in Airline Radio. Henry W. Roberts. Development story of radio equipment for the airlines through the efforts of their nonprofit service organization, the Aeronautical Radio Co. Inc. The Bendix Radio Corporation is completing an order of 300 communications units known as the RTA-1 ten-frequency combined transmitter and receiver. The new units will replace present airline equipment. A similar though smaller unit is also being developed by the Bell Telephone Laboratories and Western Electric Company for use on ultra-high frequencies, together with a new 30-frequency push-button type receiver for UHF radio range navigation, traffic control, and instrument landing. *Aero Digest*, November 1940, pages 50, 53, 134, 3 illus.

Communications Unit. Detailed description of the airlines' new 10-frequency transmitter and receiver unit RTA-1. *Aero Digest*, November 1940, page 89, 2 illus.

Stress Analysis

A Nomogram for Beam-Columns. H. P. Liepmann. A nomogram from which can be found the value and location of the maximum moment and the distance between points of inflection for a single-span beam-column subjected to a uniform side load. *Aviation*, November 1940, pages 62, 126, 1 illus.

Rechteckige Blechhaut unter gleichmassig verteiltem Flussigkeitsdruck. (Thin Rectangular Sheet Metal Under a Uniformly Distributed Fluid Pressure.) M. Neubert and A. Sommer. The airplane builder is interested to know the stresses to which construction parts of rectangular sheet metal are exposed. Flying boat hulls and floats receive special consideration, as they have to withstand heavy water pressure on take-offs and landings, or during maneuvering in heavy sea. Consideration is given also to fuel tanks which often are under considerable internal pressures, due to high acceleration. *Luftfahrtforschung*, July 20, 1940, pages 207–210.

Flight Load Factors. This is a complete reprinting of C.A.B. Report No. 6, discussing U.S. load factor requirements. After giving the history of the problem, starting from the Army Air Corps work previous to the entrance of Government control in 1926, the report gives the history of load factor requirements and their constant change in relation to power and reliability of aircraft engines. New terminology is given, as well as the latest

material on load factor prediction and the methods of determining present day load factors. Gust load factors and maneuvering load factors for large airplanes is discussed. *Civil Aeronautics Journal*, October 1, 1940, pages 438–442, 2 illus.

Warfare

Aircraft Recognition. Exercises in recognizing the identity of airplanes from a distance. *The Aeroplane*, September 20, 1940, page 1, 4 illus.

The Violation of London. British editorial on the bombing of London. *The Aeroplane*, September 20, 1940, pages 307, 308. 1 illus.

In the Midst of Death Over England. Robert Low. Close up of fighter action off an English airdrome known as Hell's Corner. *Liberty*, October 26, 1940, pages 17, 18, 1 illus.

Air Raid Key Charts. Seven charts showing location and density of British air raids to date. *Aeronautics*, October 1940, page 69.

Delenda Est. Fougueux. There are anxious moments at the base awaiting the return of a British bombing squadron. When they arrive with news of a successful attack, there is a feeling all around, of a day's work well done. *The Aeroplane*, September 20, 1940, pages 322, 323, 1 illus.

Fallacies of the Bombed. Many pros and cons of whether bombs from an airplane directly overhead or those which can be heard will strike near the observer, can be cleared up by the use of a simple formula. Bomb velocity neglecting drag, is eight times the square root of the height from which it is dropped. As bombs do not attain the speed of sound, they can be heard no matter how close by they may strike. It is also stated that while a bomb released from an airplane at a point directly overhead will not hit nearby, one released some seconds before the airplane is seen overhead would arrive simultaneously. *The Aeroplane*, October 4, 1940, page 365.

Shocking. Rebecca West. Life in London under bombing attack and problems of the human element found in crowded air raid shelters. *Saturday Evening Post*, October 26, 1940, pages 16, 48, 50, 2 illus.

The War in the Air. England's chief air defense problem, according to the writer, is effective protection against night bombing. It is believed that the Nazis are marking London and other important areas with intersecting radio beacons. High flying night bombers travel along one beam and when the second intersects their line of flight, they simply unload and turn back to their bases. *The Aeroplane*, October 4, 1940, page 367, 1 illus.

Direct Hit. Quentin Reynolds. Nightly raids over London as seen and reported by an American correspondent. *Colliers*, October 19, 1940, pages 11, 90, 2 illus.

The Faith of an Empire. Air warfare developments in Britain have built up an unshakable faith in air power, and a grim determination on the part of the British people to build toward air supremacy, and an air tradition such as their Navy has long held on the seas, according to this lead editorial in *The Aeroplane*. Especially in the use of bombers, the attitude of the British has changed from a marked distaste to a realization that they must be used in ever increasing numbers to destroy the Nazi war machine and the horror it has loosed upon the world. It is stated that the British people now realize the magnitude of the job of air armament and air warfare ahead of them, but are highly confident that it can be done successfully. *The Aeroplane*, October 11, 1940, pages 389, 390.

The Battle of Britain. Cy Caldwell. The story of Hitler's first major defeat. Air preparations for invasion began on schedule but were soon thrown off schedule and then completely checkmated, first by a few hundred Spitfire and Hurricane fighters and later by the ceaseless pounding of invasion bases by bomber squadrons of the R.A.F. The air battle over Britain is reviewed to date from the standpoint of air strategy and reasons advanced for anticipating a long contest of endurance. *Aero Digest*, November 1940, pages 34–36, 188, 2 illus.

The War in the Air. Summary of the 57th week of the air war over Britain. Bad weather impedes the operations of fighters but bombing raids continue. Of especial interest is a statement by the writer that there are increasing signs of American participation in the war, and that permission may be given for officers of the United States Army Air Corps to be attached to R.A.F. Squadrons to gain first hand experience. Included is a summary of air action against the Italians in Egypt, and a picture chart of German and British airplane losses for the week. *The Aeroplane*, October 11, 1940, pages 395–398, 8 illus.

The Bombing of Towns. J. M. Spaight. An interpretation of the rules governing land warfare by the Hague convention of 1907. *Aeronautics*, October 1940, page 40.

The Onslaught on London. Weekly news account together with a score sheet of the week's attacks over London. *The Aeroplane*, September 20, 1940, pages 312, 315, 4 illus., 2 tables.

The 54th Week of the War in the Air. Summary of Britain's air war effort for the preceding week. *The Aeroplane*, September 20, 1940, page 312, 1 illus.

55th Week of the War in the Air. The week ending September 27, was marked by steady increase in the night bombing of London and the continued pounding of German war production centers by British long range bombers. A pictograph shows losses for Britain of 48 fighters and 10 bombers; for Germany 196 bombers, 72 fighters. *The Aeroplane*, September 1940, pages 337–341, 14 illus., 1 table.

The Air Minister on the War. Sir Archibald Sinclair, British Secretary of State for Air, reviews present status of the war in the air. *The Aeroplane*, September 27, 1940, page 335.

Italy and the Mediterranean. Summary of the air war between Italy and Great Britain together with an organization outline of the Italian Air Force. Performance specifications and diagrammatic drawings of Italian military airplanes are given in addition to a map of North Africa, Southern Europe and the Near East which shows potential German and Italian air bases. *The Aeroplane*, September 27, 1940, pages 342–346, 18 illus.

Air Strategy XXIII—Air Blockade XIII. Captain Norman Macmillan. If the Royal Air Force can break the Luftwaffe, the rest of the war is merely a mopping up job according to this writer. Showing that the outcome of this blockade and counter-blockade type of war depends on who can break the enemy's front line of fighting craft, not only by direct combat losses, but by destruction of factories and training fields. Britain's training program and her sources of supply, beyond bombing distance by enemy craft, is partial compensation for the head start Germany had in both training and production. The writer again makes a plea for a unified Air Arm, divorced from both Army and Navy control, and suggests the assignment of a division of the Bomber Command for constant offensive action against training and production centers. *Flight*, October 10, 1940, pages 302–304.

Thumbs Up! C. G. Grey. Hit the other fellow before he has a chance to strike you. That was the sentiment expressed by Viscount Trenchard, father of the R.A.F., according to the message cabled to the United States from England. The lesson that day raids were not too difficult to cope with, but that the night brought real peril from the skies was well learned in France, Belgium and Holland. The real job was to keep the night raids to a minimum, so that the manhours in the factories of England would not be diminished. *Aviation*, November 1940, pages 30, 31, 2 illus.

House Organs and Catalogues

Complete Meterological Equipment

The Friez line is exceptionally diversified and complete, offering every type of meteorological instrument for measurement and recording of temperature, humidity, wind, barometric pressure and precipitation. The first part of the catalog features complete weather station installations. The other divisions show types and size ranges of various instruments. Six pages are devoted to aircraft flight analyzers and meteorographs, and there is a description of the Friez Radio Meteorograph, carried aloft by a free balloon.

The catalog is well illustrated, and its method of classification, plus a subject and an alphabetical index, makes it easy to use. *Friez Standard Weather Instruments, Catalog No. 7,* Julien P. Friez & Sons.

Stratoliners Coast to Coast

Flight booklet by TWA featuring its new coast to coast Stratoliner service. Color photographs showing the appointments of the Boeing Stratoliners offer a study in luxurious travel. *Broader Wings Now Span the Nation,* published by Transcontinental & Western Air Inc.

Plastic Engineering Service

Engineering service in the field of laminated materials is offered without charge by one of the oldest companies. National Vulcanized Fibre Company, *National Inform-a-Sheet,* Issue 8.

Aircraft Finishes

"Titanine" Aircraft Finishes include a complete line of aircraft dopes, primers, thinners, rust preventatives, varnishes, polishes, lacquers, enamels, rejuvenators and paint removers. The third edition of their catalogue opens with a short history of aircraft dopes, and a list of products. The remaining two-thirds of the book is given over to finishing instructions and specifications for metals, fabrics, plywood, with special attention given to refinishing and rejuvenating fabrics. A humidity chart and suggestions for air conditioning the dope room are given together with color samples of the company's products. International Paints Ltd. *"Titanine" Aircraft Finishes,* 3rd Edition.

Facsimile for Aviation

The Finch Duplex Facsimile Unit transmits and receives facsimiles simultaneously permitting the pilot to send to a ground station, military or naval headquarters sketches of what he sees. Messages, photographs and maps may also be transmitted from one airplane to another and from the ground to the airplane. This illustrated booklet outlines its military, naval and commercial aviation uses together with technical data and specifications. Finch Telecommunications Incorporated.

Research at Lockheed

Lockheed's Experimental Research Laboratories. A brief picture of the facilities and organization of Lockheed Aircraft Corporation's new Research and Testing Laboratory. Functions will include the building and testing of models, conducting structural tests of parts, sections and members, tests of electric and hydraulic equipment, experimental work in chemistry, metallurgy, and production research. Its research engineers will carry out planned programs under three group headings—the Structures Research Group, the Mechanical Research Group, and the Production Research Group. Specialists in each group will work on the problems in his own field, and at the same time coordinate his efforts and results with those of his group associates. *Lockheed Aircraftsman,* October.

Instrument Technician School

The addition of a school for instrument technicians is announced in the October issue of the Spartan School News. The course, under the direction of R. G. Ojers, recently of the instrument department of TWA, will be limited to 30 students. *Spartan School News,* October.

New Line of Machinists' Tools

A new line of machinists' tools is presented in a recently issued folder catalogue by the George Scherr Company. Included are machinist combination sets, dividers, calipers, center gages, thickness gages, depth gages, surface gages, and magnifiers. Also to be found are hook, sliding caliper flexible and narrow tempered rules. George Scherr Co. *Machinists' Tools.*

Republic to Train 8000

8000 new aircraft workmen will be sent to school by Republic Aviation Corporation to supply the manpower needed in its new plant which will be ready January 1st. According to the announcement the company will train 1000 men per month through the facilities of the Faust Aircraft School at Jericho, N. Y. All tuition will be paid by Republic Aviation Corporation, and all men who complete the course satisfactorily will be given immediate employment in the company's plant. *Republic Aviation News,* October 18th.

Spark Plug Performance

Seventeen thousand take-offs and as many landings is the operating record of one of Boston and Maine Airways' Lockheed transports, according to the booklet on Simmonds-Benton Aircraft Power Plugs. Operating record of Simmonds-Benton plugs under these conditions of increased take-offs and idling periods is given in a letter from Boston and Maine Airways. The booklet also contains details of construction and plug sizes for various aircraft engines. *Simmonds-Benton Aircraft Power Plugs.*

Close-Up of a Bomber Squadron

Visit to an R.A.F. Bomber Squadron. Warren Irvin. An American newspaperman's account of his visit to a British bomber squadron, covering preparations, take-off, action over objectives and the return. He emphasizes the fact that British bombers often return with full bomb loads when military objectives are not located, in compliance with strict orders not to bomb non-military objectives. *London Calling,* October 15, 1940.

Mechanics for the Air Corps

Boeing School of Aeronautics is spending $150,000 to provide expanded facilities for the training of mechanics for the U.S. Air Corps. With a capacity of 300 students, classes of 25 men each will be enrolled every two weeks, and at the end of six months will also be graduated at two week intervals. *Boeing School News,* October 15th.

(Continued on page 45)

From the Industry

Releases are printed as received from companies and other aeronautical organizations and the responsibility for the accuracy of all statements is therefore not assumed by the Aeronautical Review.

Aeronautical Chamber of Commerce of America

At a recent meeting the Public Relations Committee of the Aeronautical Chamber of Commerce of America was reorganized and expanded to broaden the scope of the Chamber's information activities in view of the increased public interest in aviation. A. M. Rochlen of Douglas Aircraft was elected chairman, L. D. Lyman of United Aircraft, Vice-Chairman; and Howard Mingos, Vice-President of the Chamber, secretary.

Besides the above the members of the committee include: S. A. Hedberg, Aviation Manufacturing Corp.; F. R. Neely, Bell Aircraft Corp.; Herbert Sharlock, Bendix Aviation Corp.; James P. Murray, Boeing Aircraft Co.; E. N. Gott, Consolidated Aircraft Corp.; H. E. Lawrence (alternate, Mark E. Nevils), Curtiss-Wright Corp.; John M. Rogers (alternate for A. M. Rochlen), Douglas Aircraft Co.; Thomas H. Corpe (alternate, S. W. Voorhes), Lockheed Aircraft Corp.; Leland R. Taylor, North American Aviation, Inc.; William A. Forbes, Platt-Forbes, Inc.; J. A. Fitz (alternate, Harris Hull), Sperry Gyroscope Co.; and T. C. Sullivan, Vultee Aircraft, Inc.

John C. Ingram, well-known newspaper man and aviation writer, has joined the staff of the Chamber's information department.

Air Associates, Inc.

To meet increased manufacturing and warehouse needs, Air Associates, Inc., oldest and largest manufacturer of special parts and equipment for the aviation industry, will start construction within a few weeks of a $200,000 one-story plant at the Los Angeles Municipal Airport, Ray Acre, Vice-President in charge of West Coast Operations, announced today.

The expansion is the second move of the company in recent months. On October 1st the home office of Air Associates was moved from Roosevelt Field, L. I., N. Y., to a new half-million dollar plant at Bendix Airport, N. J. The West Coast branch has been located at the Grand Central Airport at Glendale since 1935; the new factory will face the Air Lines Terminal at Los Angeles Municipal Airport.

The new plant is the first unit of an extended building program. Capacity of present West Coast operations will be doubled.

Curtiss-Wright Corporation

The latest type of Curtiss-Wright Interceptor-Fighter airplane, designed by the St. Louis Airplane Division of the Curtiss-Wright Corporation to climb over a vertical mile in 60 seconds as an effective weapon against invading enemy bombers, was demonstrated publicly for the first time on November 19th as a feature of ceremonies marking the breaking of ground at Lambert Field, St. Louis, Mo., for the largest aircraft plant in the Middle West, according to C. W. France, Vice-President and General Manager of the organization.

Called by its designers the fastest climbing airplane in the world to their knowledge, the Curtiss Model 21B—as it is technically known—is a highly streamlined, single-place, low-wing, all-metal monoplane powered with a Wright Cyclone engine, and equipped with the latest military aircraft accessories. These include an electric "Tell-Tale" or warning signal which automatically checks the airplane's performance and is invaluable to the fighter-pilot.

The new well-camouflaged fighter, one of a large number now being built for delivery to a foreign government, has four machine guns which fire through its propeller disc. Equipped with oxygen facilities and radio communication, it proves much more effective than anti-aircraft batteries in combating high-flying enemy bombers, according to its designers, because of its mobility and the rapidity with which it may be directed by friendly ground or air forces against an attack from any direction.

Department of Commerce Civil Aeronautics Administration

The airport approval board consisting of the Secretaries of War, Navy and Commerce, charged with responsibility for location of sites to be constructed or improved under the recent $40,000,000 national defense airport appropriation by Congress, has designated Major Lucius D. Clay, Corps of Engineers, U.S. Army, as its secretary.

Colonel Donald H. Connolly, Administrator of Civil Aeronautics, said Wednesday that Major Clay has established offices in the Commerce building.

Simultaneously, Colonel Connolly announced that in order to expedite the construction program, the C.A.A. Airport Section under Major A. B. McMullen has been detached from the Federal Airways Service and will operate as an independent unit directly with the Administrator and with Major Clay.

Colonel Connolly pointed out that provisions of the appropriation act limit the expenditure of the $40,000,000 airport fund to not more than 250 sites deemed most important to national defense by the priority board.

He said that the C.A.A. is now engaged in a detailed study of airport projects before it, in conjunction with the Army and Navy, and that at least 30 days will be required to develop data in proper form for consideration by the approval board composed of the three secretaries.

Most of the required data are already on file, Major Clay said, but where information is regarded as insufficient, representatives will visit prospective locations for further facts within 30 days. He warned, however, that such visits constitute no assurance that the specific projects will be included in this year's program.

It is expected that, after the detailed facts have been presented to the approval board, the defense locations can be determined in time for a considerable portion of the work, both by contract and force-account, to be under way by the opening of the new year.

Colonel Connolly said that information about individual projects may be obtained by correspondence with the secretary of the approval board, in care of the Administrator of Civil Aeronautics.

Douglas Aircraft Company

Powerful new Douglas attack-bombers, originally ordered by the government of Norway, are now being delivered in Canada.

This was disclosed October 29th by officials of Douglas Aircraft Company, who announced the first three 8A-5s in an order for 36 are in flight to Toronto for delivery to Norwegian military units. The attack-bombers were built in the company's El Segundo, California, plant, with deliveries scheduled for completion before close of the year.

An export version of Douglas attack-bombers now in use by the United States Army Air Corps, the 8A-5 is latest in a series previously purchased by Peru and Iraq.

Powered with a 1200-hp. Wright Cyclone Engine, the craft has a top speed in excess of 265 m.p.h. and a service ceiling of nearly 32,000 ft. One of the most formidable of its type, the airplane is armed with seven machine guns, and although primarily an attack ship, it has substantial bomb capacity.

Sub-contracts in excess of $75,000,000 will soon be placed by the Douglas Aircraft Company with middle-west and eastern manufacturers.

This became known when President Donald W. Douglas announced on October 25th, that necessary specifications and agreements with automotive and manufacturing concerns in Pennsylvania, Ohio, Michigan, Missouri, Colorado and California would soon be completed.

Construction of these parts and sub-assemblies in eastern industrial centers will materially speed national defense production and will help spread employment throughout the nation, Mr. Douglas said.

Coincidentally with this announcement, Major Carl A. Cover, Vice-President and General Manager, and Walter A. Hamilton, Chief of Materiel of Douglas, released the list of principal sub-contractors and the names of officials who negotiated the proposed agreements for their respective organizations.

Lion's share of the Douglas sub-contract business in the present national defense procurement will go to the Murray Corporation of America, the Briggs Manufacturing Company, the Fisher Division General Motors Corporation, all of Detroit, Michigan, and to Fleetwings, Inc., Bristol, Pennsylvania; Goodyear Aircraft Corporation, Arkon, Ohio; McDonnell Aircraft Corporation, Robertson, Missouri; and Aircraft Mechanics Inc., Colorado Springs, Colorado.

Large orders also are slated, Mr. Cover and Mr. Hamilton said, for Solar Aircraft, San Diego; Hammond Aircraft, South San Francisco; Hardman Aircraft Products, Inc., South Gate; Axelson Manufacturing Company, Los Angeles; and Vega Airplane Company of Burbank in California.

The first of 36 attack bombers ordered by the government of Norway. Shown with the airplane are members of the Royal Norwegian military mission to this country. Left to right: Lt. Odd Schyberg, Engineer Harald Sundt, Lt. Arve Aas, Technician Erling Drangsholt, Commander K. A. Ostby, Major Victor Bertrandias (Vice-President of the Douglas Aircraft Company), Technician Helge Torgersen, Engineer Reidar G. Halvorsen, Lt. Kaare Kjos, Lt. Ludvig Brannvoll, and Engineer Einar Hvam.

All parts and sub-assemblies manufactured in the East will be shipped to the new Douglas plant at Long Beach, California, where complete airplanes will be assembled and turned over to the Army and Navy under the accelerated defense program.

In addition to bringing new business to eastern and mid-west communities—with prospects that the total involved will eventually pass the $100,000,000 mark—the sub-contracts will create 12,000 additional jobs for a period of two years. This does not include transportation and other activities. A staff of 25 Douglas engineers, inspectors and experts, with headquarters in eastern centers, will coordinate this outside production. Directing the Douglas forces in the field will be Fred Essig and Fred Rockelman.

While amounts involved in individual contracts have not been finally determined, it is known the largest allotments to individual companies will exceed $20,000,000 each.

To speed national defense Douglas executives began preliminary studies and negotiations with the sub-contractors months ago, and were well underway before the first of the procurement contracts with the United States government were signed. At the same time engineering and estimating studies were progressing at full speed under Arthur E. Raymond, Director of Engineering and Frederick W. Conant, Assistant General Manager, while on other fronts complete organization plans, building designs, and personnel-training projects for the Long Beach unit were being hurried along.

Nearly two score eastern executives and engineers spent weeks working on the record-breaking parts order.

C. W. Avery, President; R. C. Gazley, Chief Engineer; C. Marvin, Methods Engineer; F. E. McGary, Tool Design Engineer; F. E. Wikander, Plant Layout Engineer; F. Kennedy; and J. W. McEachren represented the Murray Corporation of America.

For the Briggs Manufacturing Company, R. Pierce, Treasurer, and D. Hartwick, Engineer, came to Santa Monica. Fleetwings was represented by Frank De Ganahl, President, C. Burbert and W. L. Sutton, Engineers.

Ed Fisher of General Motors conferred with the Santa Monica executives on behalf of his company. The Fisher works will do most of the tooling for the sub-contracting work, Materiel Chief Hamilton said.

Goodyear was represented in the negotiations by A. Potthoff and the McDonnell Company by J. H. McDonnell, President.

The Glenn L. Martin Company

First prize for outstanding development in plastics in the airplane transport group has been tendered The Glenn L. Martin Company by the magazine *Modern Plastics*. Receiving the plaque for the development of plastic airplane trim tabs was Glenn L. Martin, president of the company and pioneer aircraft manufacturer.

Sharing in the same award were the Formica Insulation Company, of Cincinnati, Ohio, and the Taylor Fibre Company, of Norristown, Pa. These

companies collaborated with the Martin company in the development.

With a strong accent on plastic development in airplanes, the tabs are regarded as an important step in the further use of the nation's boundless plastics supplies. Extensive work in plastics has been done at the Martin company, especially through the company's fellowship at the Mellon Institute of Industrial Research at Pittsburgh.

Tests have shown certain outstanding virtues of the plastic tabs. Of laminated phenolic fabric base, they weigh considerably less than their metal counterparts and yet they show a much greater strength. Because they are resilient, they keep their shape under heavy stress, where metal tabs have been known to warp and bend permanently under strain. In addition, the surface is smooth and uninterrupted by rivets, such as the metal tabs have, thereby lessening wind drag. The plastic versions are affected neither by moisture nor corrosion.

Where with a conventional tab it was necessary to cut the metal, bend it to form, and hold it together by rivets, with the new plastic construction the outer skin and the laminated interior structure are fabricated in one piece by a single application of heat and pressure. Tests also have shown a 25 to 35 percent greater resistance to bending and also a much greater resistance to buckling. They have stood twice the hours on vibration test required of metal tabs.

Glenn L. Martin holding the plaque his company won as first prize for plastics development in airplanes for the last year.

Probably more value accrues in the potentialities demonstrated by these small pieces than in the advantages of the tabs themselves as working parts. Because plastics are lighter, of almost unlimited supply and capable of being formed by hitherto non-critical industries, such developments are considered highly important in war.

Kollsman Instrument Division, Square D Company

A completely new Elapsed Time Aviation Clock, combining elapsed time and second setting features with the standard Kollsman Eight-Day Aviation Clock, was announced by the Kollsman Instrument Division of the Square D Company on November 13th.

An over-all dial and large hands indicate time in the usual manner. A large sweep-second hand, making one revolution in one minute, is set in motion by pressing a small button at the bottom of the clock. A small dial in the upper right section of the over-all dial serves as the totalizer dial for the sweep-second hand, accumulating the time of this hand up to sixty minutes. The sweep-second hand and totalizer are stopped by pressing a button. When pressed again, both the second and totalizer hands return to zero.

A miniature clock dial, with two conventional hands located in the upper left section of the over-all dial, registers elapsed time during flight up to twelve hours. This totalizer is set in motion by pressing the winding knob, and a red dot in the small dial indicates that the minute and hour hands of this special dial are in operation. To allow for time out, the winding knob is pressed again. A silver dot then replaces the red dot, indicating that the hands are stopped. In resuming elapsed time the winding knob is pressed again and the red dot reappears, indicating that the hands are again in motion. On completion of flight, the totalizer is stopped by pressing the winding knob, while the hands of the totalizer dial are returned to zero by pressing another button.

This clock is especially constructed to meet the strict requirements of aircraft use, its performance at normal and extreme temperatures, and at any stage of winding, fully meeting the exacting U.S. Army and Navy specifications. Any possibility of stripping under rough treatment is eliminated by careful arrangement of the winding and setting mechanism to insure proper meshing of wheels and pinions.

Extra heavy mechanism plates, sturdy pivots and jewel bearings assure proper functioning even under severe vibration and shock. Because of its integral, monometallic balance wheel, and hairspring of special alloy, the clock's accuracy is constant during temperature changes. A completely rustproof hairspring assures faultless performance in a damp climate.

Except for bearing pivots and a few small parts, non-ferrous metal is used. As the clock's accuracy is not affected by magnetism, it may be mounted adjacent to a compass without affecting the action of the compass.

This unique clock weighs but 7 ounces. The standard hour and minute hands, numerals and five minute graduations are Radium Luminous coated, while all other hands and graduations are painted white. Although designated as an eight-day clock, it is not necessary to rewind punctually on the eighth day. It will actually run ten days on one "winding," thus allowing a two-day margin.

Kollsman Elapsed Time Aviation Clock

Lockheed Aircraft Corporation

Describing the record-breaking coast-to-coast flight of G. T. Baker, President of National Air Lines, as "stock plane performance," Robert E. Gross, President of the Lockheed Aircraft Corporation, today declared that the achievement of the Florida air transport executive was a testimonial to the advance in modern airline operating technique and equipment.

Baker, delivering the first of a fleet of three 14-passenger Cyclone-powered Lockheed Lodestars from Burbank to the headquarters of his company at Jacksonville, established a new transcontinental record for transports of 9 hours, 29 minutes, 39 seconds, on November 2nd. Making one stop at Dallas, Texas, to refuel, Baker and a crew of four covered the 2357 mile distance at a speed of more than 240 m.p.h., to shave 1 hour, 4 minutes, from the 10-hour, 34-minute mark established by Howard Hughes in 1938.

"One feature of the flight," Mr. Gross said, "was the fact that the Lodestar was a standard air transport in every sense of the word and was operated exactly as if it were being flown on schedule over an established airway.

"It was a 'stock-plane' equipped for immediate use for the transportation of passengers, baggage and mail. Standard seats and all required and desired airline equipment had been installed and was in its place while the transcontinental record was being established. Nothing was eliminated to lighten the load nor extra gas tanks provided to extend

range or performance. Fuel capacity was the normal 650 gallons of gasoline provided in ships of its type."

Calling attention to the precision timing with which the flight was executed, Mr. Gross stated: "Prior to the take-off, Mr. Baker said his primary purpose was to demonstrate not only the speed but the extended cruising range of the modern air transport as used on the airlines today, under virtually the same conditions as would be encountered in actual service. The manner in which he carried out his plans is a testimonial to airline operating technique."

The Lodestar was flown exactly in accordance with a predetermined flight plan drawn up by Mr. Baker and his crew several days before the start. This plan called for a 3 a.m. take-off from Union Air Terminal, a 5-hour, 28-minute flight to Dallas where 20 minutes were allowed for refueling, and a total elapsed time of 9 hours, 30 minutes for the entire distance from Burbank to Jacksonville.

"At no time," Mr. Gross stated, "did Mr. Baker sacrifice a normal airline margin of safety for speed. For example, in estimating fuel consumptions, he allowed for a reserve of 60 gallons upon arrival at Dallas. Actually, the 1200 hp. Wright Cyclones consumed only 45 gallons each per hour—a total of 90 gallons per hour—with the result that the ship landed at Dallas with 155 gallons of gasoline still in the tanks.

"Approximately 100 gallons of this fuel reserve could have been converted into higher speed on the Burbank to Dallas leg, had Mr. Baker so desired, and further reduced the flying time. He preferred, however, to operate at the cruising speed normal for the 12,000 to 13,000 ft. at which the ship flew."

Powered with two 1200 hp. Wright Cyclone engines, the Lodestar has a top speed of 260 m.p.h. at 8200 ft. and cruises at 230 m.p.h. at 12,000 ft. with 14 passengers, a crew of three, and a full load of mail, baggage and express. According to Mr. Baker, he used an average of only 62½ percent of the engines' normal rated sea level power, or 625 hp. per engine. No oil was added during the flight.

Mr. Baker, one of the few airline presidents who holds a commercial transport license, had as members of his crew La Pierre Cavender, of Lockheed, co-pilot; Kenneth J. Boedecker and Robert E. Johnson, of the Wright Aeronautical Corporation, Flight Engineers; and Adolph Merta, of Lockheed, Flight Mechanic. Boedecker was the service engineer who prepared Colonel Charles A. Lindbergh's "Spirit of St. Louis" for its New York to Paris solo flight in 1927. The only passenger was Norman Lee, of New York City, first man to fly entirely around the world as a paying passenger using only scheduled airlines. He gained this distinction in 1939 when he covered 24,000 miles in 19 days.

The Lodestar is the first of a fleet of three ships to be delivered by Lockheed to National Air Lines for operation over "The Buccaneer Route" between Miami and New Orleans via Jacksonville. The second ship will be flown to Florida within the next few days by E. J. Kershaw, chief pilot for N.A.L.

According to Mr. Baker, the new Lodestars will be placed in operation on or about December 15th to supplement the smaller Whirlwind-powered Lockheed Electras which have been used over the line since 1936.

Keeping pace with plant expansions to meet National Defense orders from the United States for its interceptor, as well as to fulfill contracts with the British for Hudson bombers and the export model of the interceptor, it was announced November 8th that employment had passed the fourteen thousand mark for the first time in the history of the company.

There were 14,312 persons employed at Lockheed on November 1st, with an average of ninety being hired each day, according to personnel figures released by Mr. Gross. These figures did not include some 2500 employees of the Vega Airplane Company, a subsidiary of Lockheed.

National Aeronautic Association

The Collier Trophy for outstanding service to aviation during the year 1939 has been awarded to "the airlines of the United States for their high record of safety in air travel with special recognition to Doctors Walter M. Boothby and Walter Randolph Lovelace, II, of the Mayo Foundation for Medical Research and Education, and to Captain Harry C. Armstrong of the U.S. Army Medical Corps at Wright Field, for their contribution to this safety record through their work in aviation medicine in general and pilot fatigue in particular," it was announced November 15th on behalf of the Board of Directors of the National Aeronautic Association by Colonel G. deFreest Larner, General Manager.

President Roosevelt will make the award in person at the White House early in December.

Members of the 1939 Collier Trophy Committee who made the award are:

Dr. George W. Lewis, Director of Aeronautical Research, National Advisory Committee of Aeronautics, Washington, Chairman of the Trophy Committee; Major General H. H. Arnold, Deputy Chief of Staff in charge of Army aviation; Miss Jacqueline Cochran, New York; Donald W. Douglas, President, Douglas Aircraft Corp., Santa Monica, Calif.; William R. Enyart, Vice-President of N.A.A., Larchmont, N. Y.; Grover Loening, Roosevelt Field, Garden City, N. Y.; Captain E. V. Rickenbacker, President, Eastern Air Lines, New York; L. P. Sharples, Treasurer, Aircraft Owners and Pilots Association, Philadelphia; Frank A. Tichenor, Publisher, *Aero Digest*, New York.

The Collier Trophy has been awarded annually by the N.A.A. since 1911, except during the World War, for "the greatest achievement in aviation in the United States, the value of which has been demonstrated in actual use during the preceding year." The Trophy was donated by the late Robert J. Collier, founder of Collier's magazine.

Volunteer Pilot Training Fund

Full scholarships, enabling them to learn to fly for national defense, were presented recently to ten young New York boys by Newbold Morris, at Floyd Bennett Field, Brooklyn, on November 2nd.

The scholarships, covering full tuition for the boys to receive their private pilots' licenses, were the first offered by the Volunteer Pilot Training Fund in their program to train more than 100 young men pledged to volunteer for military service this winter. After brief ceremonies, each of the boys took his first flying lesson from Joseph Alta, chief flying instructor for the Fund.

The purpose and function of the Fund, supported by nation-wide contributions, was announced by the chairman, Princess Ekaterine Obolensky.

"We believe there is no more vital need in the national defense of America than trained pilots," she said. "And we realize that only a small portion of the air reserve of the nation can be taught by government funds. We wish to enable young men of military age who cannot afford to fly to secure government-approved scholarships."

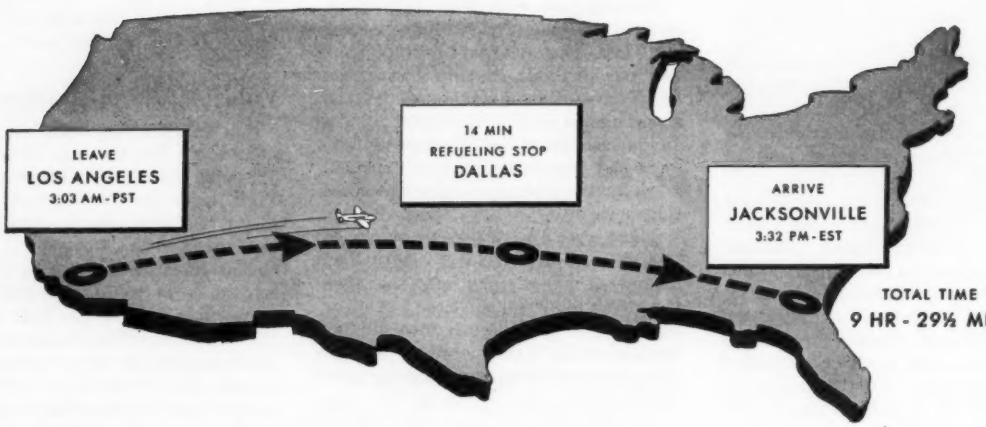
The Fund, with headquarters at 400 Madison Avenue, New York, is sponsored by the Civilian Welfare Council, National Council of Women and Women War Veterans.

Pan American Airways System

Effective January 1st, air transport schedules between the East Coast of South America and the U.S. will be further reduced to provide two-day service from Rio de Janeiro, and additional schedules, in effect doubling present capacity, will be inaugurated on all main trunk air routes between North and South America.

Establishment of the new 48-hour service from Rio de Janeiro to Miami will institute the first night-and-day

It *still* takes a Lockheed *to beat a Lockheed!*



Former Lockheed Record broken by a Lodestar!

It's a production-line Lodestar! No special superchargers ...nothing removed to make it lighter...no mechanical magic to make it faster. Yet in a 2357 mile flight from Burbank to Jacksonville... it broke all existing transcontinental speed records for transport airplanes.

Think what performance like this means to airlines! Greater speed means longer flights during daylight...cuts working time of flying personnel...allows more revenue miles per flying hours...more miles between overhauls. All sound economic reasons for flying Lodestars.

And still comfort takes no bow to speed! There's headroom for tall men...aisle space for a good stretch ...and an individual window for every passenger.

WHAT THE NATION'S FASTEST TRANSPORTS LOOK LIKE INSIDE... G. T. Baker, president of National Airlines piloted luxury through the sky on his record breaking flight. At Jacksonville, Florida, this and other Lodestars will go into regular airline service carrying passengers along the scenic Gulf Coast.

The average speed across the continent was 240 m.p.h....most of the flying done at 13,000 feet at 55% power. The new record of 9 hours 29 minutes and 39½ seconds, betters the previous record by 1 hour 4 minutes and 20 seconds...*it still takes a Lockheed to beat a Lockheed.*

LOCKHEED AIRCRAFT CORPORATION, BURBANK, CALIFORNIA

LOOK TO *Lockheed* FOR LEADERSHIP

flying on the inter-American express air routes, while delivery, in January, of 20 additional units to the Pan American fleet of high-speed landplane transports will, in effect, complete the change-over from seaplane to landplane transports on the majority of inter-American routes.

The schedules planned for inauguration in January contemplate the operation of daily service between the U.S. and Puerto Rico; daily service from the U.S. through Mexico and Central America to the Panama Canal Zone; four times weekly service over the western trans-Caribbean route to Colombia and the east trans-Caribbean route to Venezuela, together with ten daily schedules between Miami and Havana, and three daily schedules between Miami and the Bahamas.

With the new schedules in operation, Pan American Airways will provide 137 departures weekly for Latin America while the augmented air fleet will provide capacity for 500,000 passengers between the U.S. and Latin America annually. Capacity will likewise be increased proportionately for air mail and express cargo.

Republic Aviation Corporation

Forty Republic EP-1 airplanes, originally constructed for the Swedish Government and stored on the Republic flying field for the last several months, are on their way to the Philippine Islands, as equipment for the United States Army Air Corps.

Secretary of War Henry Stimson has said that the planes will be part of the equipment for two new pursuit squadrons which have been shifted to the Pacific islands to reinforce the nation's defenses there. In the Army service, the fast low wing monoplanes have been re-designated P-35A type since their design for export was developed directly from the Army's P-35 type.

The requisitioned planes include a large number of other P-35As and 2-PA "Guardsman" dive bombers, as well as those of the Swedish order which are still under construction at Republic. All will go directly into Government service.

All have been held at Republic since early summer, when the export license for them was cancelled by State Department action, on the grounds that their export would be harmful to the national defense.

While construction under the Swedish contract went ahead at the plant, the number of planes stored increased until a short time ago when Congress and the President approved the Faddis Act, permitting the Government to requisition any war materiels which are unexportable because of lack of licenses.

The Swedish planes fell into this category and were the first materiel seized under the law. The Swedish Government lodged vigorous diplomatic protests and this phase of the matter is still under discussion.

Since the airplanes were the property of the Swedish Government, the financial negotiations in the matter do not directly affect Republic Aviation Corporation, and it is supposed the United States will directly reimburse Sweden for the cost of the planes.

Railway Express Agency

November 7th marked the thirtieth anniversary of the first air express shipment in the history of transportation, according to local Railway Express officials.

The first package to be transported by air consisted of five bolts of silk weighing fifty pounds and valued at $1000, and it was carried in a skeleton-frame Wright biplane from Dayton to Columbus, Ohio, sixty-five miles, in seventy-one minutes, by Phil O. Parmelee, pilot, whose course for part of the way was marked by a large white streamer waved from the back of a Big Four train. The shipment had arrived in Dayton by rail express from Rogers and Thompson, New York City, and was consigned to the Morehouse-Martens Dry Goods Company, Columbus.

Orville Wright was in the crowd at the Wright Aerodrome to witness the take-off, and the package was delivered to a representative of the consignee at Driving Park, Columbus, one hour and eleven minutes later.

With a brisk tail wind, a modern transport plane carrying passengers, mail and express recently flew over the Dayton-Columbus route at a six-mile-a-minute speed, agency men said.

Ryan School of Aeronautics

Arrangements have been completed for official dedicatory ceremonies at the new $200,000 Air Corps Training Branch of the Ryan School of Aeronautics at Hemet, California, November 11th, according to Earl D. Prudden, School Vice-President and General Manager.

Actual training operations have been under way since early in September when fifteen cadets from the Ryan training detachment at San Diego arrived at the new school to form the essential nucleus of the cadet company. These men have now completed their training and new classes of 70 cadets are arriving every five weeks.

A huge building program has been completed, but the actual lay-out of the school is such as to provide for immediate expansion of facilities should such a request come from the Air Corps. Present buildings include two hangars, maintenance shops, ten administration and classroom buildings, nineteen barracks units and a large dining hall, canteen and kitchen.

Three million square feet of the half-mile-by-mile field have been oiled and a paved ramp 236 by 600 feet adjacent to the hangars has been provided. Thirty-seven days after construction began the new training school was in operation.

Captain Lloyd P. Hopwood is Commanding Officer of the new training detachment. He is assisted by Lieutenant W. S. Ford. Flight training is under the direction of Verne Murdock, and maintenance and technical training is supervised by Walter K. Balch.

The Waco Aircraft Company

Indicative of industry's desire to cooperate with the government in carrying out the National Defense program is the achievement of the Waco Aircraft Company in turning out PT-14 training planes for the Civilian Pilot Training Program, under which private flying schools are authorized to train pilots according to the regulations set up by the Civil Aeronautics Administration.

Commenting today on the swiftness with which the aircraft industry is meeting the emergency, Clayton J. Brukner, President of Waco, said: "Although the demands of flying schools participating in the C.P.T.P. for ships which meet the C.A.A.'s rigid standards of specification and performance has imposed a heavy burden on existing plane building facilities, we, like other plane manufacturers, are prepared to do our part.

"Already, we are devoting more than 80 percent of the production capacity of our factory at Troy, Ohio, to the building of PT-14 trainers, although we are not acting under government contract or any agreement other than the orders received from private flying schools. Under our expanded production program, we are turning out three finished trainers a day, seven days a week.

"This has not been an easy job," Mr. Brukner continued, "because our PT-14 was approved for the secondary training program only last June 21. We delivered the first unit to Metcalf Flying Service, Toledo, on August 4, and by August 12 were completing two planes a day, seven days a week. This figure was increased to three a day by September 19.

"In June 1940, our workmen were turning out a limited quantity of custom-built cabin ships for private owners. Today, 6 times as many men are building 21 trainers a week, without seriously disrupting cabin plane production. This, we feel, is quite an accomplishment in view of the obstacles presented by scarcity of materials and skilled workmen and by the necessity of maintaining the most rigid standards of inspection."

6 Round Trips To the Moon!

MARTIN CLIPPERS ROUND OUT FIVE YEARS TRANS-PACIFIC

Record . .

NUMBER OF TRIPS
361

ROUTE MILES FLOWN
2,994,717

PASSENGER MILES
12,718,213

PASSENGERS CARRIED
3,973

MAIL TON MILES
568,720

EXPRESS TON MILES
274,735

FIVE YEARS SHUTTLING back and forth across the biggest ocean of them all—the 8,500-mile Pacific! That is today's record of Martin's famed "China" and "Philippine" Clippers. Few, if any, airplanes ever built have equalled the gruelling service of these Pan-American Airways ocean airliners—10,000 hours flight time between California and the Orient for each of them. Or, more strikingly expressed, each of these airplanes has spent nearly one quarter of the past five years in the air—actually 23.9% of the actual hours since November 22, 1935.

AND TODAY these airplanes are as sturdy as ever, still first ships of the line, taking their regular scheduled turns over the Pacific route! They have traveled almost 3,000,000 route miles, carried nearly 4,000 passengers with heavy loads of mail and express, and every week the amazing record increases—with no end in sight.

THESE "SHIPS that couldn't be built," piloted by the late famed Captain Edwin Musick, soared westward from San Francisco on the first scheduled trans-oceanic air service on November 22, 1935. Today, men and women and children casually step aboard these first air leviathans and are whisked across the vast ocean in luxurious comfort and in a fraction of the time of surface vessels.

THE GLENN L. MARTIN COMPANY pays tribute to Pan-American Airways and its skilled personnel for the magnificent record of operation. And MARTIN takes justifiable pride in having conceived, engineered and constructed these modern ocean airliners—worthy contributors to the advancement of peaceful air commerce.

TODAY MARTIN PRODUCTION is devoted to defense. But when peace again rules this world, MARTIN will send forth greater and faster airliners to increase world commerce under the Stars and Stripes.

THE GLENN L. MARTIN COMPANY, BALTIMORE, MARYLAND, U. S. A.

MARTIN USA
TRADE MARK

MARTIN

BUILDERS OF DEPENDABLE AIRCRAFT SINCE 1909

News Review

October 1. The United States Army will be reorganized to provide fighting units of the Air Corps in each of the nine corps areas. Plans were made for setting up units of varying types for convenience and control.

October 2. American Export Airlines announced the purchase of T.A.C.A., a leading Central American airline. Lowell Yerex, founder of the latter airline, will retain a substantial interest.

October 2. Two squadrons of the U.S. Army Air Service, one a pursuit and the other a bombing unit, were assigned to Anchorage, Alaska. These are the first tactical aviation units to be sent to this outpost to guard the northwest approach to the North American continent.

October 2. The State Department requested the Vichy Government in France to return the U.S. built military aircraft, now held in Martinique.

October 2. Prominent New Jersey citizens have been asked for contributions of not less than $1000 each to aid in the re-opening of Newark Airport as a co-terminal with LaGuardia Field, New York.

October 3. The French Government at Vichy, in reply to the State Department's request for the resale of the U.S. built planes held at Martinique, stated that they could not comply, due to the terms of the armistice with Germany.

October 3. The U.S. Army Air Corps announced an increase in the number of Combat Groups from 38 to 54.

October 3. Many applicants for flight instruction under the C.P.T.P. refuse to sign pledge drawn up by the C.A.B. which commits all trainees to apply for flight training in the military services of the United States.

October 3. According to the incomplete lists made up by the State Employment Services throughout the United States, only 1600 of the 177,000 skilled workers seeking employment have the necessary experience for employment in the aircraft industry.

October 4. The Senate, in adopting a report from the Appropriations Committee, ignored the Post Office's request for $500,000 to equip American Export Airlines for transatlantic service.

October 4. Civil Functions Appropriations Bill passed, providing $40,000,000 for the building and improvement of 250 airports.

October 4. The first American unit of parachute troops adopted by the Army will be set up at Fort Benning, Georgia. The new unit, known as the 501st Parachute Battalion, started with 500 men.

October 4. Rear Admiral John H. Towers stated that the United Aircraft Corp. of East Hartford, Conn., has built the fastest pursuit airplane in the world. Powered by a 2000 hp. engine, it is reported to be faster than any fighting airplane used in Europe.

October 4. Army and Navy orders for airplanes and engines, placed since July 1, 1940, total $1,227,668,237.

October 6. Major General Frederick Martin, Commander of the Third Wing of the U.S. Army Air Corps at Barksdale Field, Louisiana, will assume command of the U.S. Army Air Force in Hawaii.

October 6. The G.H.Q. Air Force's long standing request for new long range bombing airplanes was fulfilled by the placing of orders for 650 four-engined late type airplanes in the flying fortress class. Four hundred and fifty of these will be built by the Consolidated Aircraft Co. in San Diego.

October 9. The new C.A.B. Building at LaGuardia Field was formally presented to the City of New York.

October 10. One hundred and ten Republic pursuit airplanes and light bombers, built for Sweden, were requisitioned by the Army. The War Department stated that the airplanes were urgently needed for advanced training.

October 11. The War Department revealed that every airplane factory in the United States had been asked to work a 24-hour day wherever feasible.

October 11. The Photographic Section of the Army Air Corps tested a new billion candlepower photographic bomb. Flying 5000 feet over Rochester, N.Y., the bomb demonstrated that it could illuminate a five mile area to the light of day.

October 12. Glenn L. Martin, President of The Glenn L. Martin Co. of Baltimore, Md., was awarded the Daniel Guggenheim Medal "For contribution to aeronautical development and the production of many types of aircraft of high performance." He will receive the award at the Honors Night Dinner of the Institute of the Aeronautical Sciences on January 28, 1941.

October 13. Lieutenant-Colonel J. Victor Dallin resigned as manager of the new Philadelphia Airport to become Director of the Pennsylvania Bureau of Aeronautics.

October 13. American Airlines, Inc., has sold an issue of 50,000 shares of cumulative, convertible, preferred stock, without par value, to meet a $2\frac{1}{2}$ percent installment promissory note of $2,250,000. The balance of the net proceeds will be used to pay for future deliveries of new airplanes.

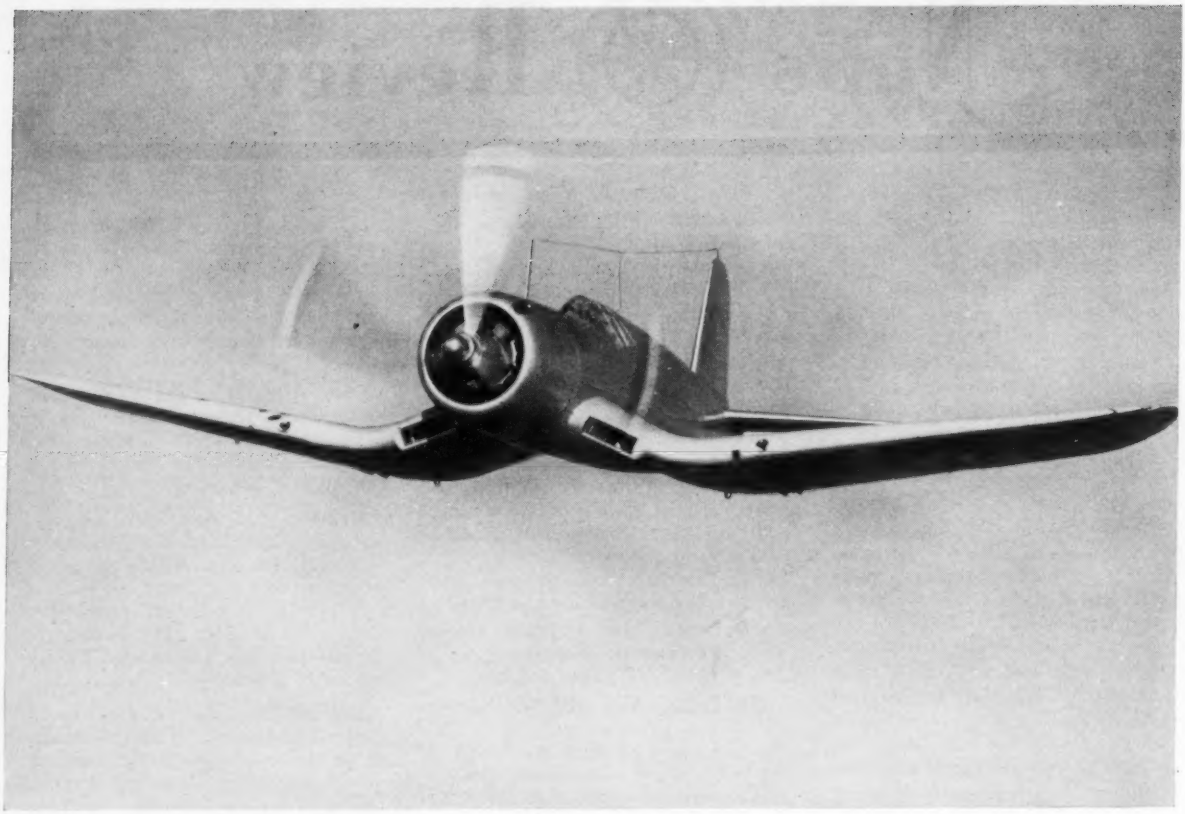
October 14. Mayor Jackson of Baltimore, Md., in laying the cornerstone of the Administration Building at the Baltimore Municipal Airport, indicated that the terminal, which has been under intermittent construction for several years, was fast approaching completion.

October 15. Republic Aviation Corp. of Farmingdale, L.I., announced that it would train 8000 aircraft workers at its own expense. This will cost approximately $1,000,000. When completed, it will provide workmen for mass production of airplanes in Republic's new plant which opens about January, 1941.

October 15. Governors of the seventeen states served by Eastern Air Lines took part in the dedication of Eastern's new building in Rockefeller Center, New York City. From their home states, the Governors pressed down telegraph keys which lit up bulbs on a huge map, representing the main air terminals of their particular state.

October 15. The Navy's new $15,000,000 air station at Jacksonville, Florida, was commissioned six months ahead of schedule. The new base will start, on January first, a course of training for Naval Reserves who have already received one month of primary training at Reserve Aviation bases now in commission.

October 16. The Bill for extending pensions and other benefits to Air Corps Reserve Officers who were disabled while on extended active duty,



America's Fastest

UP, UP, UP go the speeds of America's military airplanes . . . and this new Vought-Sikorsky fighter for the U.S. Navy is being hailed as the fastest of them all. Sleekly streamlined, it combines tremendous speed with long range and the ability to land safely on the limited area of an aircraft carrier's deck.

Highly significant is the fact that this fast fighter is powered by a Pratt & Whitney Double Wasp engine, the most powerful ever installed in an airplane of this class. Thus, the radial air-cooled engine, which has contributed so much to aviation's progress in the past 15 years, again leads the way to new achievements at this crucial period in America's aeronautical history.

UNITED AIRCRAFT
CORPORATION
East Hartford, Connecticut

VOUGHT-SIKORSKY AIRPLANES
PRATT & WHITNEY ENGINES
HAMILTON STANDARD PROPELLERS

subsequent to July 1, 1928, was vetoed by the President.

October 16. The War Department disclosed that the original program for training 12,500 Army pilots annually will be increased to 24,900.

October 17. A fleet of non-rigid lighter-than-air craft will be created by the Navy to patrol the Caribbean from a new Naval Air Base in Florida.

October 17. The $2,000,000 Coast Guard Air Station at Elizabeth City, N.C., was dedicated by Representative Lindsay C. Warren of North Carolina.

October 19. Dexter Martin, Director of Aeronautics for South Carolina, was elected president of the National Association of State Aviation Officials at the organization's tenth annual convention at Louisville, Ky.

October 20. Merrill C. Meigs, noted flyer and publisher of the Chicago Herald and American was named as head of the aircraft division of the National Defense Advisory Commission. Meigs succeeds Dr. George J. Mead, formerly a United Aircraft Corp. executive, who resigned from the commission in order to engage in research at the N.A.C.A.

October 22. Captain Harold L. Neely, U.S.A.C., of Lowry Field, Colorado, received the Distinguished Flying Cross for landing his disabled airplane when both engines failed.

October 23. The first radio program ever sponsored by an airline on a major network was a news broadcast featuring Boake Carter, war-time pilot and commentator. This is the first of a series of tri-weekly broadcasts.

October 23. A forecast was made by the National Association of Commercial Organization Secretaries, that the airlines will carry an increasing proportion of freight and express shipments during the next decade.

October 24. The 110 airplanes built by the Republic Aviation Corp. for the Swedish Government and taken over by the Army Air Corps are being shipped to the Philippine Islands.

October 25. Transcontinental and Western Air completes its first decade of service.

October 25. Major-General H. H. Arnold was named Deputy Chief of the General Staff, and will be in charge of coordinating all matters pertaining to the Air Corps. Major-General George H. Brett was elevated to Acting Chief of the Air Corps. Major-General Delos Emmons, G.H.Q. Air Force Commander, received a "temporary" promotion to Lieutenant-General, while Brigadier-General John F. Curry, Commander of the Tenth Pursuit Wing at Hamilton Field, was promoted to Major-General.

October 29. Pan American Airways asked the C.A.B.'s permission to fly an alternate transatlantic route Portugal to Portuguese Guiana, thence to the coast of South America.

October 29. Neutrality Rules have been altered to permit transatlantic airplanes to fly over war zones in order to avoid bad weather.

November 1. John B. Walker, Regional Traffic Manager of United Air Lines, was elected President of the Airlines Terminal, Inc., the group controlling the new airline terminal building in midtown New York.

November 1. Pennsylvania Central Airlines opened a new air link from Norfolk to Knoxville. Mid-Continent and Braniff also start new routes. The new routes total 1536 miles.

November 1. Mme. Marie Leonia Nungesser, mother of the famous World War flyer, was killed in a bicycle accident in France.

November 2. G. T. Baker, President of Northwest Airlines, established a new west-east transcontinental record in a standard Lockheed Lodestar, by flying from Burbank, California, to Jacksonville, Fla., 2357 miles in nine hours and forty-five minutes.

November 3. Argentina announced the opening of an armament drive for the republic. Five thousand flight officers will be trained and $90,000,000 will be spent on aircraft.

November 3. A new altitude record was made for light airplanes by Miss Grace Huntington of Pasadena, California. The new mark is 24,311 ft., in a 75 hp. Taylorcraft.

November 5. The C.A.B. report on the recent crash on Bountiful Peak near Salt Lake City stated that it was caused by a faulty radio beam.

November 6. Unfilled orders for aircraft throughout the United States now exceeds $3,000,000,000.

November 6. Martin A. Allen, pioneer parachute jumper, died at his home at the age of 90. Allen, with his two brothers, established an exhibition troop of balloon parachute jumpers in 1877. Allen made his last jump after his 75th birthday.

November 7. The War Department announced that it had awarded a contract for 4000 Pratt & Whitney engines to the Ford Motor Company of Dearborn, Mich. The amount was $122,323,020.

November 8. Jacqueline Cochran was awarded the Harmon Trophy for the third time for establishing five national and two international records, and making the first blind landing ever completed by a woman pilot.

November 8. Brigadier-General Frank M. Andrews, first Air Corps officer to be attached to the Army General Staff, was nominated for temporary promotion to Major-General, and assigned to the command of an Army Air Force in the Panama Canal Zone.

November 8. Frank A. Tichenor was elected Chairman of the newly formed Aeronautical Council for the Department of Commerce.

November 8. The new Airlines Terminal Building, built to serve all the air lines serving New York, is expected to be ready for occupancy early in 1941.

November 10. The National Youth Administration is planning to build a series of seaplane floats on the water ways and coastal waters of the U.S.

November 11. Colonel G. E. Brower and Major D. T. Craw arrived at Cairo, Egypt, to take up their assignment with the U.S. Air Corps Mission with the British.

November 12. United Aircraft Corp. reported a net profit of $2,971,662 for the quarter ending September 30, 1940, unfilled orders amounting to $189,550,879. Approximately 80 percent of the shipments of engines for the nine months ending September 30, 1940, were for export. The total sales and operating revenues for that period reached $78,714,377 as compared with $34,183,518 for the same period in 1938.

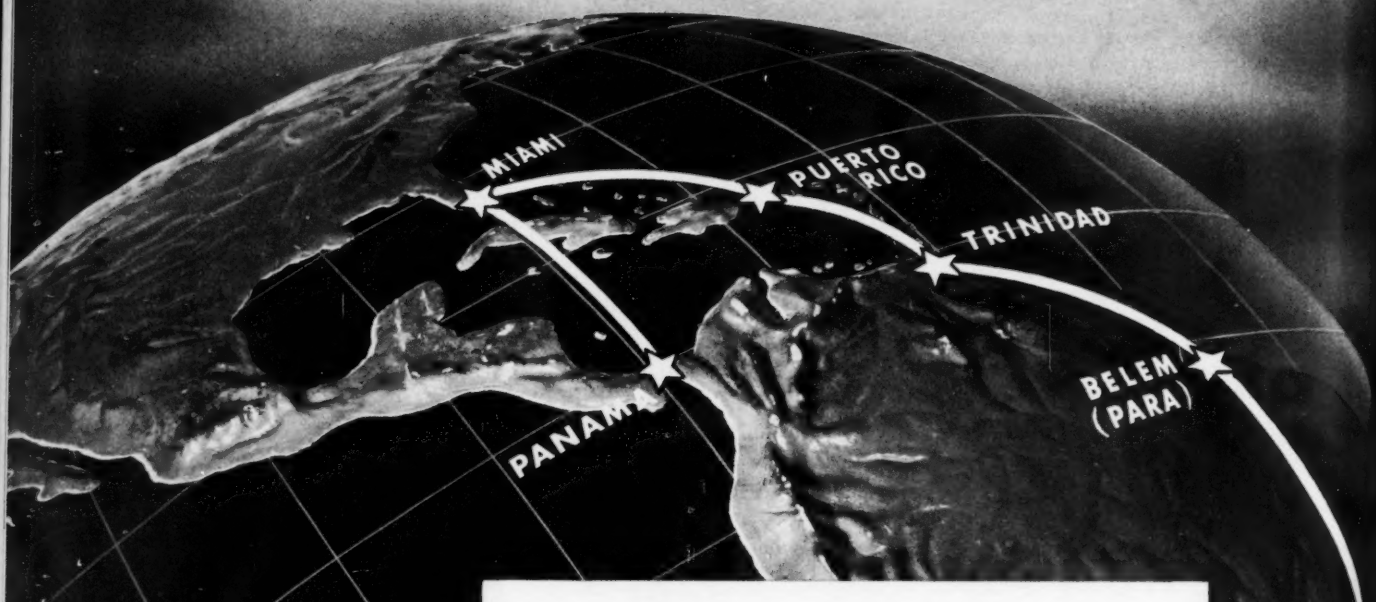
November 12. U.S. Navy selects Splacentia Bay on the Southern coast of Newfoundland as one of the naval and air bases received under the trade agreement involving 50 over-age U.S. destroyers, recently concluded.

November 13. The Directors of the Brewster Aeronautical Corporation, in an effort to speed up production on their $100,000,000 backlog, appointed new executives. The new board are as follows: James Work, Chairman of the Board, George F. Chapline, President and General Manager, Dayton T. Brown, Vice-President in charge of Research and Development, and William L. Smith, Vice-President in Charge of Materials.

November 13. The War Department will permit British Airmen to attend Pan-American Airways' school of navigation and long distance flying at Miami, Florida.

Cyclone-powered Strato-Clippers ply the

HIGH ROAD TO RIO



PAN-AMERICAN'S NEW BOEINGS NOW PROVIDE *3-day Service*

Miami today — Rio day after tomorrow! Pan American Airways links the Americas with swifter wings. A new fleet of Boeing Strato-Clipper landplanes — each powered by four 1100 H.P. Wright Cyclones and named for early Yankee Clipper ships—flies non-stop from Miami to Panama . . . cuts two days off former schedules to Rio de Janeiro and Buenos Aires.

Pan American inaugurated its regular Trans-Atlantic service and extended its Trans-Pacific services with Boeing 4-engined flying boats powered by Wright Cyclones. Once again selected for Pan American's international operations with the new Boeing Strato-Clippers, Cyclones are playing their part in strengthening the unity of the Americas.

IT PAYS TO FLY

WRIGHT AERONAUTICAL CORPORATION

A Division of Curtiss-Wright Corporation • PATERSON, NEW JERSEY

WRIGHT *Aircraft* ENGINES

High Altitude Flight

A bibliography giving references for research in this specialized field. Revised and brought up-to-date from the fifty volume Bibliography of Aeronautics compiled and published with the cooperation of the Works Projects Administration from the Aeronautical Index of the I.Ae.S.

Engineering Aspects

1940

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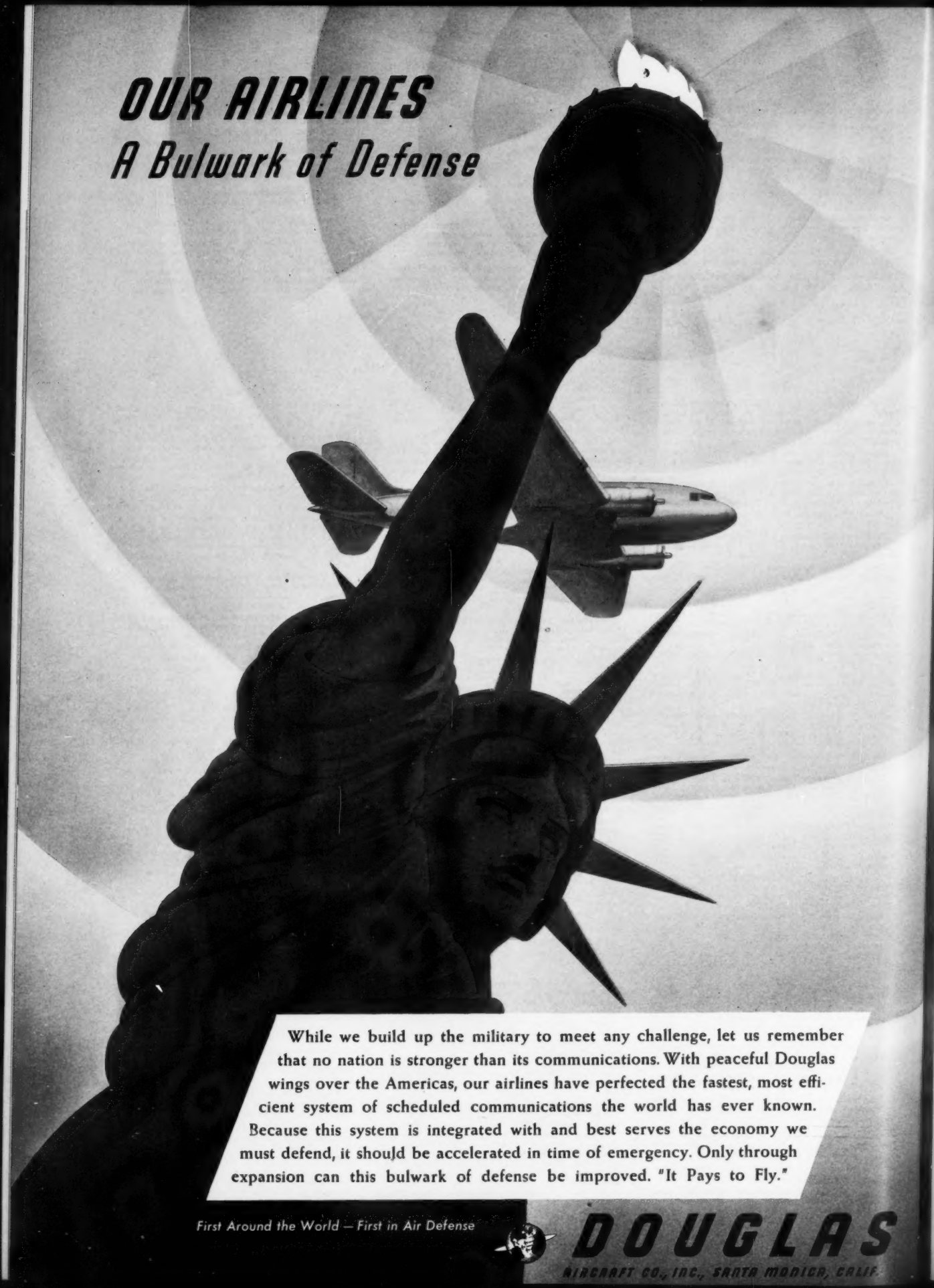
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House Organs and Catalogues

(*Continued from page 25*)

Aircraft Plastics

Plastics in National Defense. John Delmonte. The use of plastics as bonding agents for veneers has interested many engineers and manufacturers. Three general methods are used to unite the wood and plastic to form a material superior to the wood alone for modern aircraft construction. Cold setting plastics may be applied; or the plastic may be forced into the wood with the use of heat and either high or low pressure. Besides the use of plasticized wood for wings, fuselages or empennage, solid plastics are used for windshields, turret window, ducts, fairings, ammunition boxes, and even seats. The author, who is the technical director of the Plastics Technical Institute, states that two of the great needs of aircraft manufacturers is a plastic with better elasticity and a controllable, low rate of creep. *Lockheed Aircraftsman*, October 1940.

Design for Higher Speeds

Fundamental problems in designing high speed airplanes are presented by R. W. Palmer, Vice-President in charge of Engineering of Vultee Aircraft. High speed airplanes of tomorrow will have glass-smooth surfaces, laminar flow wings, and be designed for a minimum of compressibility drag. *Vultair*, October.

Wright Torque Indicator

A precision torque indicator which enables engineers to measure engine horsepower aloft in flight tests was used in performance tests of the latest Curtiss-Wright transport. Accuracy of the torque indicator was shown to be equivalent to the conventional ground dynamometer. The indicator will greatly simplify the comparison of data on ground performance and flight performance of aircraft engines. *Wright Tradewinds*, October 16th.

Engine Balance at High Speeds

Battle for Balance. Investigations of dynamic balance and the individual balancing of crankshafts as pioneered by the automotive industry have contributed to the development of high speed engines for military airplanes. *Automobile Facts*, October.

Work Simplification

Common sense time and motion study applied to mass production of airplanes eliminates waste, promotes safety and efficiency at North American Aviation Inc. *North American Skyline*, October.

Hardening High Speed Steels

Tools, tricks, and problems of heat treating and quenching are presented in a four-page file size folder prepared by engineers for heat treaters everywhere. Lindberg Engineering Company *Heat Treating Hints.*

Review of the Effects of High Altitude Flying

ROSS A. McFARLAND*

Introduction

The most important physical variables which affect the human organism while in flight in the modern commercial airplane appear to be vibration, noise, ventilation, temperature, rate of ascent and descent, and altitude. With the possible exception of rate of descent and altitude, these factors have been brought well within the so-called comfort zone. Their elimination as unpleasant aspects of flying will soon be brought about by the skill of technical engineering. The most important physical variables which remain to be controlled appear to be the physiological and psychological impairment resulting from the lack of oxygen available for the organism at high altitude and the action of sudden changes in barometric pressure on the eardrum of the middle ear. These two problems are also intimately tied up with engineering skill, for their solution lies in the development of supercharged cabins.

This review is concerned with the effects on pilots and the average civilian passenger of the diminished partial pressure of oxygen encountered while in flight at high altitudes. The development of the human organism has, for the most part, taken place relatively close to sea level. There are millions of people who have become acclimatized to altitudes as high as 8,000 to 14,000 ft. in the mountainous regions of the Andes, the Alps and the Himalayas. However, transporting the human body by airplane to similar altitudes, even though for short periods of time, cannot help but have marked effects on various organic functions. In spite of the amazing capacity of the human organism to adjust to sudden changes in the physical environment, whether it be extremes in temperature, in humidity, in the ionization of the air, or in the barometric pressure and the consequent alteration in the available oxygen supply to the tissues, the problem demands thorough scientific analysis. The eventual success of commercial air transportation, in competition with other means of travel, appears, among other things, to be intimately associated with maintaining a relatively normal organism during, and at the end of each flight.

Physiologists have been interested in the effects of high altitude for many years. A number of extensive investigations have been carried out during varying periods of acclimatization in mountain expeditions, notably those of Haldane, Henderson and Schneider to Pike's Peak (1911), of Barcroft *et al.* to the Peruvian Andes (1922) and of Dill *et al.* to the Chilean Andes (1935). In the Alps extensive investigations have been carried out by Mosso, Zuntz and Loewy. More recently Hartmann has made studies at very high altitudes in the Himalayas. There is also an extensive amount of data available from the experiments of the physiologists and psychologists who selected the pilots for altitude flying during the World War with the rebreather apparatus and low pressure chamber. In addition, there is an extensive literature dealing with many specialized aspects of the effects of oxygen deprivation in chamber experiments with rebreathing devices and with Douglas bags. Although the data from all of these sources are relevant, the experimental procedures have not duplicated the specific rates of ascent and altitudes which are experienced by passengers during the average flight on Civilian air lines.

The Physical Factors of the Environment at High Altitude

The air which is inspired at sea level contains, by volume, and on the dry basis, 20.93 per cent of oxygen (O_2), about 78 per cent of nitrogen (N_2), 0.04 per cent of carbon dioxide (CO_2), and about 1.0 per cent of the inert gases, argon, neon, zenon, krypton and helium. Since oxygen constitutes about one-fifth of the air, the partial pressure of oxygen alone, therefore, is 159 mm. Hg. As one rises above the level of the sea, the pressure of the atmosphere falls (barometric pressure) so that at any given altitude the concentration of gases in a given volume of air is reduced. At 19,000 ft., for example, although the composition of the air is unaltered, the total atmospheric pressure and the partial pressure of oxygen are reduced one-half. The partial pressure of oxygen in the lungs is less than half that at sea level; also atmospheric air becomes saturated with water vapor at 37°C., as it reaches the alveoli of the lungs regardless of the barometric pressure. Thus 47 mm. of pressure must be deducted from the 760 mm., giving us dry air in the depth of the lungs at a pressure of 713 mm., a reduction of about 6 per cent at sea level. When the barometric pressure is one-half normal, the diluting effect of water vapor will be twice as great as at sea level. There is a reduction of oxygen percentage from that in the atmosphere to that in the alveoli (due to dilution by the residual air of the lungs) of one-fourth or even one-third. We have, therefore, at sea level in the alveoli an oxygen percentage of 14 to 15, and an oxygen pressure of 103 mm. Hg on the average. The partial pressure of

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The Boeing 307 Stratoliner, equipped with a cabin-supercharging system, which is used by TWA and the Pan American Airways.

the oxygen of alveolar air normally is greater than that of the blood stream, resulting in a flow of oxygen from the alveoli into the blood where it is held in combination in the blood cells by means of hemoglobin.

Table 1 shows altitude in relation to the barometric pressure, the partial pressure of oxygen in the atmosphere, the partial pressure of oxygen in the alveolar air, and the percentage of oxygen available for the organism.

TABLE 1

Altitude (in feet)	Barometric Pressure (mm. Hg)	O_2 Pressure (mm. Hg)	O_2 Pressure in Alveolar Air (mm. Hg)	Equivalent per cent O_2 in Air Diluted with N_2 at Sea Level
Sea level	760	159	103.0	20.93
6,000	602	126	78.0	16.58
10,000	506	106	63.5	13.94
14,000	444	93	53.0	12.23
18,000	380	80	45.0	10.46
22,000	328	71	36.0	9.03
28,000	253	53	20.0	6.97
30,000	230	47	..	6.33

The important factor in high altitude which causes the abnormal symptoms in the organism is the diminution, not in the mechanical or *total* pressure, but in the diminished *partial* pressure of the atmospheric oxygen and the consequent decrease in the alveolar oxygen and oxygen saturation of the arterial blood. In other words, the physiological action of oxygen and other gases depends on their partial pressures. It is generally accepted that the ill effects of altitude are primarily due to the diminished oxygen pressure.

A number of experimenters have found that even while breathing excessive quantities of oxygen life cannot be maintained much beyond 35,000 to 40,000 feet altitude. Motor incoordination, as judged by handwriting tests, and general physiological and psychological deterioration, begin in the neighborhood of 35,000 to 40,000 feet even while inhaling 100 percent oxygen. (See Fig. 1.)

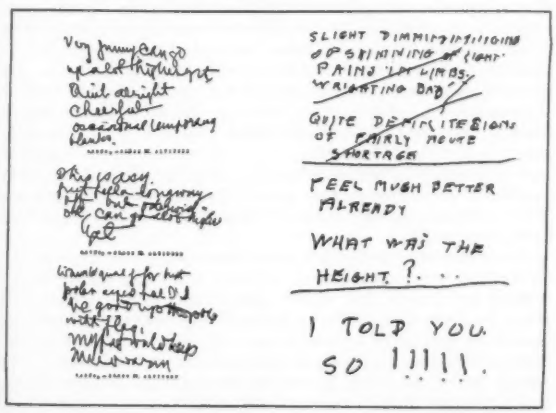

SLIGHT DIMMING/FUZZING OF SIGHT
PAINS IN LIMBS, WEIGHTING BAD
QUITE DEFINITE SIGNS OF EARLY HOUSE
FEEL MUCH BETTER ALREADY
WHAT WAS THE HEIGHT ?. . .
I TOLD YOU SO !!!!!.

FIG. 1. The handwriting on the left was made while breathing oxygen mixtures from a Douglas bag at simulated altitudes of 20,000, 23,000 and 26,000 feet (64). Note the muscular incoordination and omission of letters. The handwriting at the right was made by one of Hill's subjects in a low pressure chamber at a simulated altitude of 37,000 feet and later at 30,000 feet while breathing 100 per cent oxygen from a tube extending outside the chamber (45).

In order to keep a person in an environment similar to that at sea level while in flight at high altitude, as far as oxygen is concerned, one need only increase the percentage of oxygen in the inspired air, for the partial pressure of oxygen is correspondingly increased. In other words, to maintain a partial pressure of oxygen in the inspired air equivalent to 159 mm. Hg at the various altitudes, the percentage of oxygen should be increased in the proportions indicated in Table 2. In practice, while in flight at high altitude, these percentages should be increased, since no allowance has been made for ventilation and wastage. It is on this principle that the various types of oxygen supply apparatus used in altitude flights are constructed. By decreasing the percentage of oxygen (barometric pressure being unchanged) the partial pressure of oxygen is decreased. This is the method employed in the rebreather or altitude classification test at sea level. On the contrary, by increasing the percentage of oxygen in the inspired air, the partial pressure is increased. At 40,000 feet, for example, the barometric pressure is 148 mm. Hg and the partial pressure of the oxygen of the atmospheric air is 32 mm. Hg—too low, of course, to sustain life. If by use of an oxygen supply apparatus the percentage of oxygen in the inspired air is increased from 21 per cent to approximately 80 per cent, then the partial pressure of the oxygen of the inspired air would be 0.80×148, or 118.4 mm. Hg, a pressure capable of sustaining life indefinitely.

TABLE 2

Altitude in Relation to Barometric Pressure and Percentage of O_2 Needed to Maintain 159 mm. Hg in the Inspired Air

Altitude (in feet)	Barometric Pressure (mm. Hg)	O_2 Per cent Needed
0	760	21.0
10,000	530	30.2
15,000	440	36.4
20,000	375	42.7
25,000	315	50.8
30,000	260	61.6
35,000	220	72.8

Important Variables of High Altitude in Aviation

The response of the average passenger on a commercial transport airplane to the lowered oxygen pressure encountered while in flight may be influenced by a large number of important variables. Since these various factors are of such great importance in understanding the physiological and psychological changes associated with successful acclimatization, a number of the more important ones are listed below.

1. Height attained.
2. Rate of ascent.
3. Length of exposure.
4. Amount of physical exertion during the flight.
5. Roughness of the air and movements of the plane.
6. The physical characteristics of the individual such as
   (*a*) Age—chronological age contrasted with physiological age.
   (*b*) Tolerance due to repeated flights.
   (*c*) Amount of regular exercise each day or week.
   (*d*) Degree of fatigue previous to flight.
   (*e*) Number of hours of sleep the previous night.
   (*f*) The kinds of food ingested.
   (*g*) The amount of alcohol or narcotics previous to the flight.
   (*h*) Emotional adaptation, freedom from worry, mental conflicts, etc.
   (*i*) Degree of relaxation, or the reverse, *i.e.*, muscular tension.
   (*j*) Clinical anomalies, such as cardiac disorder, anemia, asthma, malaria, metabolic disturbances, tuberculosis, etc.

The Physiological Responses of the Organism to Lack of Oxygen and Excess Carbon Dioxide

There is no storage of oxygen in the body, unlike many other chemical substances necessary to maintain life, such as carbohydrate. In emergencies of oxygen want, the release of red cells (oxygen carriers) by the spleen and bone marrow may be considered as a storehouse in a limited sense. In man the blood is really the only storehouse for oxygen, and its capacity is very limited. Hence the body lives a hand-to-mouth existence with respect to its oxygen supply. When the available supply of oxygen is shut off, there is loss of consciousness within a minute or two. The efficiency of one's body is dependent upon the constancy of the internal environment, *i.e.*, the regulation of temperature, water, oxygen, the

hydrogen-ion concentration, etc. Since man's higher nervous faculties developed due to the constancy of these organic processes, an extreme variation in any one of them, particularly the oxygen percentage, will produce striking effects on the nervous system and other tissues of the body.

The amount of oxygen taken up by the blood depends upon the partial pressure of oxygen in the alveolar air, the temperature of the blood, the concentration of salts in the blood and the hydrogen-ion concentration of salts in the blood (carbon dioxide tension). During rest the whole blood volume passes through the lungs about once per minute, and it may pass as often as ten times during exercise. When the arterial blood is imperfectly saturated, the condition which develops is called *anoxemia*. It is indicated by the bluish color of the skin and lips.

The most important physiological changes associated with the diminished partial pressure of oxygen as encountered at high altitude are as follows: (see Fig. 2) (*a*) stimulation of the respiratory center and an increase in the pulmonary ventilation; (*b*) a decrease in the alveolar oxygen and carbon dioxide tensions; (*c*) dilatation of the alveoli favoring a more efficient respiratory exchange; (*d*) an initial increase in the heart rate and blood pressure and an increase in cardiac output; (*e*) an increase in the amount of hemoglobin in the circulation; (*f*) a decrease in the arterial oxygen saturation associated with the fall in alveolar oxygen tension; (*g*) changes in the acid-base equilibrium; the initial effect being one of alkalemia associated with the excess elimination of carbon dioxide. Sudden and extreme anoxemia depresses the activity of the respiratory center so that a delayed effect may be the retention of carbon dioxide and consequently an acid reaction in the blood. Authoritative discussions of the physiological changes associated with anoxia may be found in the works of Haldane, Barcroft, Loewy, Peters and Van Slyke, and Dill.

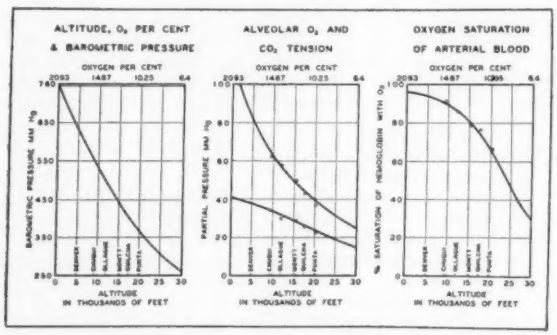


FIG. 2. These curves show the barometric pressure, the alveolar O_2 and CO_2 tension, and oxygen saturation of the arterial blood in relation to altitude based upon data from various high altitude studies. The circles represent data from the Chilean Expedition at the stations indicated. (McFarland, R. A., Jr. Comp. Psychology, 23:193, 1937.)

The Psychological Responses of the Organism to Lack of Oxygen and Excess Carbon Dioxide

The characteristics of the psychological changes induced by anoxia depend upon the rapidity and the extent to which the oxygen pressure is reduced; *i.e.*, the rate of ascent and altitude attained, as well as the length of the exposure and the physical characteristics of the individual. The psychological changes reflect the degree of organic imbalance, provided the subject does not attempt to compensate for the deterioration by exerting greater effort. Until asphyxiation reaches the stage in which the integrative mechanism is rapidly approaching the condition of complete failure, no effects are demonstrable. Discriminative judgment and memory are apparently not affected, except as the inability to attend to the details in learning, or inability to control the muscular mechanisms of expression, may enter. In the rebreathing experiments with pilots, the oxygen was reduced from 20.94 per cent oxygen (sea level) to approximately 9 to 7 per cent (corresponding roughly to 22,000 to 27,000 feet) in 20 to 30 minutes. These experiments gave a false impression of the average subject's tolerance for anoxia, since the pilots desiring to do well exerted great effort to maintain their reactions as long as possible.

If anoxemia is produced suddenly, as in an airplane ascent, the psychological effects are insidious and often overlooked because the most striking effect is on the central nervous system. At first there may be a feeling of well-being, but this stage gradually and unwittingly passes into sensory and mental dullness. When the partial pressure of oxygen is reduced one-third, *i.e.*, from 160 to 110 mm. or to approximately 12,500 feet, the aviator may be conscious of alteration in breathing, headache, and a little higher muscular effort in moving. At 20,000 feet, many experience a desire to sleep and fainting is not uncommon. In spite of obviously foolish reactions, one feels quite confident that one's mind is clear and judgment sound. The upper limit for consciousness in unacclimatized man during short exposures appears to be between 23,000 and 25,000 feet.

The handwriting and choice reaction times have been followed in a number of the pilots during a period of one hour while the oxygen was gradually depleted. At a simulated altitude of 20,000 feet, for example, one subject appeared to be quite pleased with himself and became highly amused at the slightest provocation. (See Fig. 1.) At 23,000 feet (8.5 per cent oxygen) he began to omit letters from common words and his writing became quite illegible. He complained of his feet feeling a long way off and of his inability to orient other parts of his body. At 26,000 feet (7.4 per cent oxygen) he was greatly incapacitated and yet he appeared to be cheerful and very pleased with his performance. He became quite annoyed when he was removed from the apparatus and insisted that he could go much higher. He was convinced of his marked deterioration only after seeing his handwriting. In the choice reaction time experiments, there was marked impairment above 20,000 feet. The mental and emotional abnormalities of the subjects in poor physical condition were very striking at simulated altitudes as low as 14,000 feet.

The objection is often raised that the effects of altitude cannot be adequately analyzed by psychological tests, since the subject may be able to conceal the impairment by exerting greater effort. In an attempt to control this factor, studies have been made of the effects of oxygen deprivation on responses which are not consciously controlled by the subject, such as photographing the eye movements while reading. The results showed it not only takes longer to read a given line at 14,000 feet, as indicated by the larger number of fixations, but also, the eyes do not coordinate so well, as shown by the lack of parallelism between the two eye tracks. There was a general tendency toward diminished precision in the adequacy of the ocular fixations. Since this procedure appears to be free from the effects of increased effort which in many tests masks the impairment, this proved to be a sensitive measure of the effects of oxygen lack on an unconscious and well established motor habit.

A number of experiments have shown that anoxia may not only affect the ocular muscles, but also certain other fundamental aspects of the visual mechanism itself. In testing pilots for high altitude flying in the World War in low pressure chambers and with rebreathing devices, at 15,000 feet and above there was diminished visual acuity, constriction of the visual fields, reduction in retinal sensitivity, changes in the heterophorias and increased fatiguability of the muscles of accommodation and convergence. In studies of the central visual fields by the technique of angioscotometry, it has been found that there was a progressive loss in the visual fields with increasing lack of oxygen. Even though certain visual functions are impaired at moderate altitudes, the average subject does not lose the capacity to see and to react to objects until the advanced stages of anoxia are reached.

One of the most interesting effects of oxygen lack appears to be manifested not in the blurring of outlines or in visual acuity but in the subjective awareness of the general darkening of sensations of light. This phenomenon was measured with a bio-photometer at altitudes corresponding to 7400 feet, 11,000 feet and 15,000 feet. The binocular light threshold was measured every 30 seconds (for 20 minutes) following exposure to a light intensity of 100 millilamberts for 3 minutes. The dark adaptation curves (plotting threshold against time) were elevated progressively with increased altitude, and were approximately parallel to the curve at sea level. At 11,000 feet, for example, only one subject was not reliably affected.

At 15,000 feet the decrease in sensitivity was statistically reliable for all the subjects. These changes were immediately abolished upon administration of oxygen at the end of the experiment.

Experiments at Sea Level Relative to Aviation

In an extensive investigation carried out during 1936–37 at Columbia University an attempt was made to determine the altitudes where the effects of oxygen want are first manifested and where the effects become dangerous for the average passenger of an air transport plane. The study involved the analysis of the response of over 200 subjects, varying in physical fitness and in age (from 18 to 72 years), at different rates of ascent and lengths of exposure to simulated altitudes of 10,000, 12,000, 14,000, 16,000, 18,000 and 21,000 feet. The tests included the recording of the pulse rate and the blood pressure at frequent intervals, the sampling of the alveolar oxygen and carbon dioxide, and the reaction to a series of psychological tests involving muscular, sensory and mental functions. Because of the prohibitive expense involved in testing large groups of subjects while in flight at high altitude in an airplane, experiments were made for the most part in a low oxygen chamber at sea level. The tests were then repeated on transcontinental and trans-Pacific flights.

In spite of the large individual differences, certain generalizations may be briefly stated concerning the physiological and psychological responses. There appeared to be a fairly close relationship between increase in pulse rate and height attained. A well controlled rise in pulse rate with a gradual return to more normal levels was apparently a favorable response. Subjects in poor physical condition responded with extreme variations in pulse rate, *i.e.*, either an unusually large increase, a sudden decrease, or no change at all. At moderate altitudes of 10,000 to 12,000 feet, there was a general tendency for the pulse rate to return to more normal levels provided the subject acclimatized fairly well and remained at rest. At the higher altitudes this did not occur. Rate of ascent appeared to be an important variable, since the changes in pulse rate were less extreme if an altitude of 14,000 to 16,000 feet, for example, was reached within 15 to 30 minutes as contrasted with 1 hour and 30 minutes. In the older age group (45 to 70 years) the increase in pulse rate was less extreme than in the younger subjects possessing more flexible neurocirculatory systems. In fact, the older subjects were apparently less apt to faint or collapse at the higher altitudes than the younger ones between 17 to 21 years of age. Tolerance for anoxia can apparently be improved by repeated exposures to moderate altitudes as frequently observed in the case of pilots.

The changes in blood pressure with increasing altitude were not as consistent as the alterations in pulse rate. An extreme rise or fall in blood pressure usually indicated poor acclimatization. During rapid and slow ascents to 16,000 feet and above, both the initial increase and the prolonged effects were higher during the rapid ascents. On the average, the partial pressure of oxygen was significantly higher and the carbon dioxide lower in acclimatized subjects on the Chilean Expedition compared to unacclimatized ones, as in these experiments. In contrasting the two rates of ascent, the partial pressure of oxygen was higher following the slow ascents compared to the rapid ones, indicating a significant advantage in ascending slowly.

The results of the psychological tests involving handwriting, choice reaction times, perseveration, code transliteration, and memory indicated a significant impairment for the group at 12,000 feet (13.2 per cent oxygen) where the partial pressure of oxygen in the alveolar air was roughly 50 mm. Hg and the per cent saturation of the arterial blood with oxygen 85. During the rapid ascents to 10,000 feet, there was a significant effect in the more complex mental tests involving memory. (See Figure 3.) The psychological impairment may be characterized not merely as a general slowing up of mental processes, which may be partially associated with the lethargy or effort needed to do the test, but more particularly with the qualitative changes. Attention appears to fluctuate more easily, yet in carrying out standardized mental tests which involve shifting quickly from one kind of problem to another there is marked impairment. The decreased capacity for immediate memory is similar to that observed in old age and in alcoholism.

There appears to be a marked turning point for the worse in most unacclimatized subjects at 16,000 to 18,000 feet. The handwriting becomes more illegible and words are misspelled, memory is markedly impaired, word associations are altered and judgments are not to be trusted. Under acute oxygen want the loss of capacity for self criticism or the capacity for accurate judgments about one's own deterioration is very striking. In this respect there is a close resemblance of anoxia to the progressive stages of alcoholic intoxication. The implications of these observations for pilots while flying above 10,000 to 12,000 feet are significant. At 14,000 to 16,000 feet the subjective complaints become accentuated, while at higher altitudes, *i.e.*, 18,000 feet and above, marked alterations in mood may become apparent, such as heightened irritability, indifference and anger, or, on the contrary, exhilaration and boisterousness. The most frequent complaints reported voluntarily in the experiments discussed above are tabulated in Table 3.

TABLE 3

Most Frequent Complaints Noted Voluntarily by Subjects at the Altitudes Shown Following Rapid Ascents

Complaints	10,000 feet, per cent	12,000 feet, per cent	14,000 feet, per cent	16,000 feet, per cent
Headache	10.5	33.3	62.4	66.7
Respiratory changes or difficulties	26.3	16.7	42.5	60.0
Excessive sleepiness	21.1	50.0	37.5	30.0
Vertigo or dizziness	5.3	0.0	32.5	53.3
Difficulty in concentrating	21.1	16.7	15.0	46.7
Sensory impairment	5.3	16.7	30.0	33.3
Lassitude, indifference	21.1	16.7	25.0	13.3
Fatigue	5.3	0.0	27.5	33.3

In a series of experiments at the Harvard Fatigue Laboratory the effects of exposure to simulated altitudes of 14,000 and 17,000 feet were studied in a low oxygen chamber with and without increased concentrations of carbon dioxide (3 per cent CO_2). Each experiment continued over a period of six hours. The slight alterations in psychological functions which were observed at 14,000 feet (12 per cent oxygen) became quite marked at 17,000 feet (11 per cent oxygen). The most complex functions, such as choice reaction times, memory and sustained attention (code test) were significantly altered. When 3 per cent carbon dioxide was present in an atmosphere containing 11 per cent oxygen (17,000 feet), no impairment in the psychological tests was observed, showing the great importance of carbon dioxide in regulating the utilization of oxygen. The addition of 3 per cent carbon dioxide resulted in elevating the ceiling by at least 5000 feet. In the unacclimatized subjects, the degree of unsaturation of the arterial blood appears to vary from subject to subject, although there is a fairly close relationship between efficiency of response in the psychological tests and the degree of unsaturation of the arterial blood. Unacclimatized subjects may be rather acutely impaired during six hours at 17,000 feet. The above experiments were repeated in the low pressure chamber at Wright Field. The results of the beneficial effects of 3 per cent carbon dioxide were similar, as well as the findings in the psychological tests.

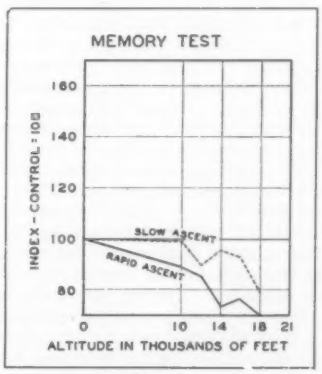


FIG. 3.

The results of other studies dealing with the psychological effects of lowered oxygen pressure are in general agreement with the findings discussed above. Tanaka found that increasing and decreasing the oxygen pressure in Haldane's low pressure chamber at Oxford significantly altered the average subject's responses on psychological tests in the neighborhood of 12,000 feet. Other psychological studies tend to support the general conclusion that approximately 12,000 feet is the critical turning point.

Experiments on Airplanes

An attempt has been made to verify the results obtained in chambers at sea level during actual flights at high altitude in airplanes. While sitting quietly in the modern transport airplanes, the effects are surprisingly slight up to 10,000 or 12,000 feet, provided the air is smooth. In experiments on trans-Andean planes to 14,000 and 16,500 feet, where the highest mountains were crossed within 45 minutes, the relative impairment was similar to that obtained in chambers at sea level with a corresponding reduction in oxygen pressure. The effects were much more marked on the Andean railway which ascends from Lima to similar altitudes (Ticlio—15,600 feet) within eight hours. On transcontinental flights on United Air Lines planes at 10,000 to 12,000 feet altitude, there was an impairment of 6 to 10 per cent in the sensory and mental tests.

The experiments on the China Clipper ships of the Pan American Airways flying between Alameda and Hong Kong were planned so as to study the same crew of eight airmen throughout a typical flight. The total flying time to China and return was approximately 134 hours, covering 15,000 nautical miles at a mean altitude of 9500 feet (cruising range 8000 to 12,000 feet). A group of 12 passengers was also studied so as to compare their responses with the airmen. Since it had been reported that these airmen suffered rather acute fatigue during these long flights at high altitude, it was important both from the point of view of safety and for the maintenance of fitness in the flying personnel to carry out carefully controlled studies during typical transoceanic operations. Following the original sea level determinations in Alameda, a series of tests were made: (1) during each day's flight; (2) at the end of each flight; and (3) on the following morning before rising. This procedure was adhered to throughout the journey and gave a basis for calculating the amount of physiological and psychological deterioration.

The findings indicated that these airmen manifested many of the characteristics of athletes and of men acclimatized to high altitudes. First, as in an athlete previous to a game, there was a tendency toward polyuria, especially in the airmen who had the greatest responsibilities. This diminished as the flight got under way for several days. Second, they had very high indices of neurocirculatory fitness, on the average approximately the same as in a large group of college athletes. However, the relative increase of the pulse rate after exercise tended to be higher as the flight progressed. Third, like the acclimatized miners, in the Andes they tended to develop low blood pressures during the flight. Fourth, they maintained a higher alveolar oxygen tension than the passengers. Fifth, there was a 10 per cent increase in red blood cells. Sixth, the protein, carbohydrate and fat metabolism were normal, as well as the blood sugar and lactic acid. There was nothing in the blood chemistry to suggest excessive physiological fatigue or intense emotional excitement. Seventh, the impairment in the psychological tests at 10,000 to 12,000 feet altitude corresponded very closely to that which was observed at similar altitudes in the Andes, the mean impairment ranging from 6 to 10 per cent.

On the whole, therefore, these airmen maintained a high degree of mental and physical fitness throughout the flight and the repeated flights to high altitude gave rise to many of the characteristics of genuine acclimatization, such as increased red cell count, a higher alveolar partial pressure of oxygen, and a tendency toward normal circulatory reactions while at high altitudes. During the early stages of this transoceanic service, the fatigue and exhaustion were no doubt quite severe. Now that accurate navigation aids and flight predictions, adequate sleeping facilities and good food at the island stations have been provided, the flight is less fatiguing. Even more important is the fact that the operations have now become routine, and therefore the apprehension associated with the initial flights over such great distances and with such expensive equipment has become less extreme. As the nervous strain has worn off, the physical exhaustion has been greatly diminished.

Alcohol and Oxygen Want

Frequent references may be found in the studies of anoxia carried out on mountain expeditions, during high altitude flights and in low oxygen chambers to the similarities in the behavior of a person suffering from oxygen want to one under the influence of alcohol. Barcroft has stated that "acute oxygen want simulates drunkenness, while chronic oxygen want simulates fatigue." Under both conditions a person may become irrational and uninhibited and lose the capacity for self criticism, memory, sensitivity and motor control. It has been suggested that alcoholism is in fact a form of anoxia (histotoxic) and that "The tissue cells are poisoned in such a manner that they cannot use the oxygen properly." This tends to explain the striking effects of alcohol on the central nervous system, since it is well known that the nervous tissue is particularly sensitive to oxygen want.

Conclusions

The following tentative conclusions may be stated concerning the effects of reduced oxygen pressure on man.

1. The Specific Altitudes Where the Organism is First Affected and Where There Is a Measurable Degree of Impairment

The maintenance of an adequate oxygen supply in the blood is such an important factor for all cellular activity that changes in the organism apparently take place as soon as one leaves the ground in an airplane. If one examines the oxygen dissociation curve in relation to the partial pressure of oxygen in the alveolar air and the barometric pressure, it is obvious that alterations would naturally take place at very low altitudes.

There is little evidence that a slight reduction in oxygen pressure, giving rise to various compensatory mechanisms such as initial increase in circulation, in hemoglobin, or in pulmonary ventilation, is necessarily harmful to the organism, especially if the person is not ill. It is also well known that frequent exercise of one's adaptive mechanisms may, on the other hand, be beneficial. The most important question, therefore, is not where the very first effects of altitude are manifested but where the alterations may be accentuated enough to actually impair one's sensory and mental functions or bring about physical symptoms of unpleasantness, such as, headaches, vertigo, excessive sleepiness, and fatigue or exhaustion.

In the series of studies on large groups of unacclimatized subjects, corresponding to an average cross section of the flying public, the first impairment on psychological functions which proved to be statistically significant was, on the average, in the neighborhood of 10,000 to 12,000 feet. The only psychological test which showed statistical reliability at 10,000 feet compared with the control was the one for immediate memory following a rapid ascent. In general, it may be concluded that the average impairment in the most sensitive and reliable psychological tests approximates 6 to 10 per cent at 12,000 feet whether the oxygen pressure is reduced within $^1/_2$ hour or 4 hours, in a chamber at sea level or in flights at high altitude.

The physiological effects are also, on the average, significantly different from the control data in the neighborhood of 12,000 feet. The initial increase in pulse rate was significant at 12,000 feet following rapid ascents but not at 10,000 feet.

Considered from the point of view of feelings of bodily discomfort, or in terms of physiological and psychological complaints the average unacclimatized passenger is significantly effected at 12,000 feet. A certain number of subjects are affected at 10,000 feet, but if one considers all of the variables, such as the numbers who might have a headache from doing the tests in normal air, etc., 12,000 feet appears to be the more critical altitude.

2. The Effects of Altitude in Relation to Rate of Ascent

The results of many investigations indicate that rate of ascent is an important variable at 10,000 feet and above. If the average subject is transported to simultated altitudes of 10,000 feet and above within 15–30 minutes the effects of the altitude are, on the average, significantly greater than when similar altitudes are attained within one hour and thirty minutes. This appears to be true of the physiological responses as well as the psychological ones.

In general it may be said that the variations in pulse rates were less extreme particularly at 14,000 feet and above following slow ascents than following rapid ones. This may be verified by observing in Fig. 3 that the significance of the observed differences were greater for each altitude following rapid ascents than following slow ones. In physically unfit subjects these differences were quite marked. At 14,000 feet and 16,000 feet, for example, a number of subjects collapsed during rapid ascents, while they became fairly well acclimatized during slow ascents to similar altitudes. The physiological and psychological complaints were also less numerous during slow ascents as contrasted to rapid ones.

3. The Cumulative Effects of High Altitude, *i.e.*, the Length of Exposure in Relation to Deterioration, or, on the Other Hand, to Acclimatization

It is quite difficult to draw conclusions from the evidence which is available dealing with the cumulative effects of reduced oxygen pressure. The problem is complicated by the fact that at moderate altitudes of 8000 to 12,000 feet one may continue to improve during exposures of 10 to 12 hours' duration due to the mechanisms of acclimatization; while at high altitudes of 15,000 to 18,000 feet, over similar periods of exposure, the mechanisms of acclimatization may be inadequate to compensate for the oxygen lack and consequently deterioration may set in after an hour or longer. From the experiments which are available thus far the evidence seems to indicate that the average person can become acclimatized to 8000 to 12,000 feet while seated quietly in an airplane (or in a chamber at sea level) for 6 to 12 hours, while exactly the opposite is true at 16,000 to 18,000 feet.

4. The Way in Which the Physical Characteristics of the Individual May Influence the Response of the Organism to High Altitude, Especially Age, Physical Fitness, Emotional Excitement, or Psychoneurotic Behavior and Alcohol

(*A*) *Age.* Experiments dealing with the response of a large group of subjects classified as to age indicate that there are significant differences in cardio-vascular responses. One of the most striking differences relates to the fact that there was a tendency for less extreme increases in pulse rate with increasing age. This indicates that the circulatory mechanisms of adaptation become more stabilized or less flexible with increasing age. Although it may be difficult to draw conclusions as to whether this is a good or poor sign of acclimatization, we observed that the older subjects were less susceptible to sudden collapse or fainting than the youngest subjects of 17–22 years of age. General observations on the air lines tend to verify these conclusions in that many subjects over 45 to 50 years of age fly with very few symptoms from the altitude alone.

(*B*) *Physical fitness and psychoneurotic behavior.* There are wide variations in ability to tolerate reduced oxygen pressure based upon the physical condition of the person being studied.

Passengers with marked respiratory or cardiac defects should be discouraged from high altitude flying because of the possible harmful effects from the reduced oxygen pressure. It has been suggested that the average cardiac patient *who can walk can also fly.* The average cardiac patient is not apt to collapse during a flight, as witnessed by the fact that so few have actually died on the commercial air transports.

The average passenger who becomes too emotionally excited or the one who is suffering from an impairment of the autonomic nervous system is apt to respond to a reduction in oxygen pressure very poorly indeed. This is in line with a previous study by McFarland and Barach in which they reported that 70 per cent of a group of psychoneurotic patients collapsed when suddenly placed in simulated altitudes of 20,000 feet compared with only 14 per cent of the control subjects. It is quite possible that those individuals who are under temporary or chronic emotional stress are apt to acclimatize poorly to a reduction in oxygen pressure since the nervous mechanisms involved in adaptation to oxygen lack are reported to be somewhat similar to the ones involved in emotional experiences (sympathetic nervous system). The results of investigations tend to substantiate the general observations of pilots that passengers who are especially "nervous" or emotionally excited are apt to be affected adversely by high altitude.

(*C*) *Alcohol.* Some evidence is available of the effects of alcohol on the average passenger under reduced oxygen pressure, which indicates that the action of alcohol is greatly accentuated at high altitude. This appears to be substantiated from the observations on the commercial air transports that those who react to altitude most severely as manifested by excessive sleepiness, headaches, or nausea, have indulged in excessive amounts of alcohol previous to the flight. The average passenger should be discouraged from the use of alcohol previous to flying and the implications are obvious for the pilots who are in control of the airplane.

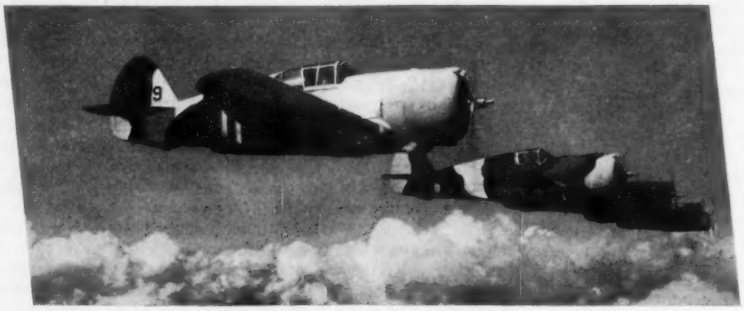
5. The Role of Carbon Dioxide in Facilitating Acclimatization to High Altitudes

One of the most important effects of a reduction in oxygen pressure at high altitude is to bring about variations in breathing and an alteration in the delicate balances of the alveolar oxygen and carbon dioxide. The results of experiments indicate that 3.0 per cent of carbon dioxide in the inspired air gives rise to an increased pulmonary ventilation and a greater saturation of the arterial blood with oxygen which lowered the altitude by approximately 5000 feet. An accumulation of 2 to 3 per cent of carbon dioxide in the fuselage of an airplane might prove to be of practical significance in greatly increasing the pulmonary ventilation.

6. Interpretation of the Effects of High Altitude on the Human Organism

The important factor in high altitude which causes the abnormal symptoms is the diminished partial pressure (or concentration) of atmospheric oxygen and the consequent decrease of oxygen in the alveolar air and arterial blood. On the average, there is a significant amount of impairment in behavior, both physiologically and psychologically when the partial pressure of oxygen in the alveolar air drops to approximately 50 mm. and the saturation of arterial blood is as low as (roughly) 85 per cent (approximately 12,000 feet altitude). It should be kept in mind, however, that oxygen lack has profound effects throughout the organism and that there is apparently no single mechanism of acclimatization of outstanding significance.

It may be tentatively concluded from these and other studies of the effects of reduced oxygen pressure that the impairment in psychological functions may be attributed to the alterations in both the oxygen and carbon dioxide; or more specifically, to the diminished partial pressure of oxygen in the arterial blood being delivered to the nervous tissue. This psychological change is probably cellular in origin, rather than due to alterations in circulation, in body temperature, or to the accumulation of unoxidized metabolic products. It is known from previous investigations that the alterations in the circulation or in the body temperature must be more extreme than those which occurred in these experiments to bring about an impairment in sensory or mental functions. The vasomotor reactions known to occur under diminished oxygen pressure produce vasodilatation and increased blood flow to various centers of the brain. But the increased blood supply cannot fully compensate for the reduced oxygen supply and as a result the amount of oxygen reaching the cerebral tissue is reduced and the carbon dioxide tension altered. The final result is a diminished amount of oxygen being delivered to the brain. The most important abnormal symptoms of high altitude under 30,000 to 35,000 feet, therefore, can be alleviated by the maintenance of a normal partial pressure of oxygen (159 mm. Hg) in the inspired air.



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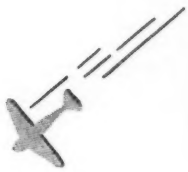

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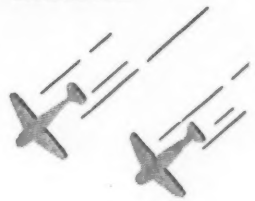

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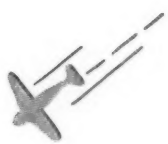

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